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A CONSOLIDATION OF ENGINEERING AND MINING JOURNAL AND MINING AND SCIENTIFIC PRESS

Development of Treatment Methods for Complex Ores
By Robert George Hall

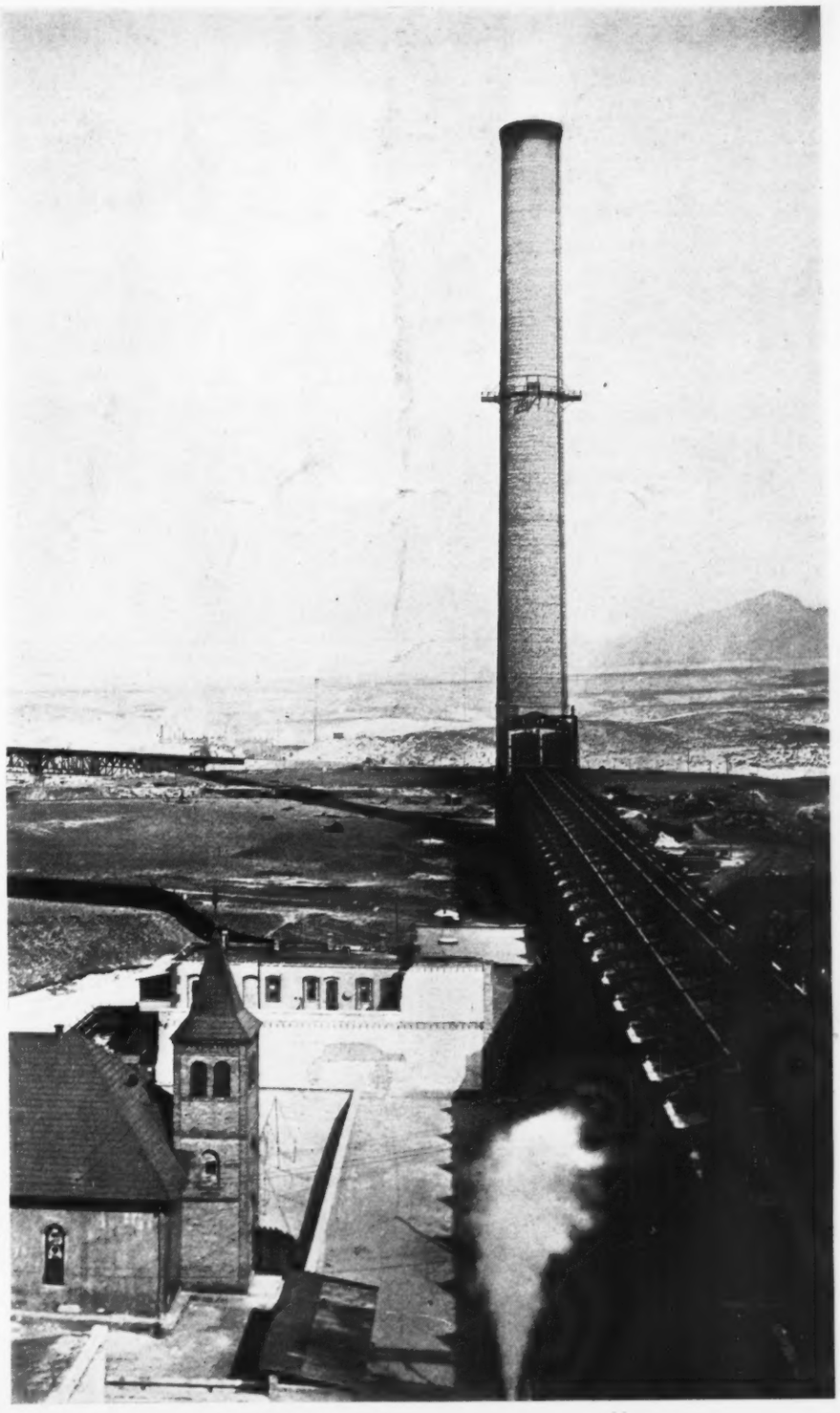
Nevada's Newest Silver Producer—The Betty O'Neal Mine
By Walter S. Palmer

Marine and Rail Freight Rates on Metals, Ores and Concentrates

What British Columbia Offers the Prospector
By A. W. Davis

Pacific Coast Steel and Its Significance for Western Iron Mining
By Ellsworth Y. Dougherty

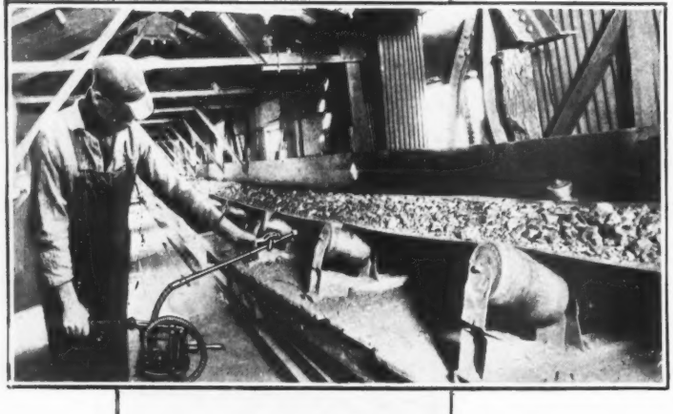
Canadian Institute's Meeting at Toronto



A landmark on the Rio Grande—Stack of the El Paso Smelting Works, El Paso, Texas

It is here that Chino's copper concentrates, and lead ores from the Ahumada and Erupcion companies are reduced

WE HERALD THE LATEST DEVELOPMENT IN THE DESIGN OF S-A UNIT CARRIERS



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ENGINEERING & MINING
JOURNAL-PRESS
JOSIAH EDWARD SPURR, Editor

Volume 117 | New York, March 15, 1924 | *Number 11*

A Call for Lead

LEAD PRODUCTION is the most prosperous of mining activities today, owing, of course, to the unusually high price of the metal. The demand for lead has been so strong that domestic mining companies have been unable to fill it. In fact, consumers have bought heavily of foreign lead, which has to hurdle a tariff of 2½c. per lb. before it can be admitted to this country in the form of bullion. This is indeed a period for operating lead mines to full capacity or beyond and bringing those lead prospects which have indications of becoming producers to activity. Unfortunately, new lead mines, as we have pointed out repeatedly, are scarce. Their development has not kept pace with the increased world-wide consumption of the metal. This has caused many well-informed observers to anticipate permanently high prices for lead—hardly at the present level. The situation is discussed at length in our market section this week.

Lead is an exceedingly useful metal, and there are certain industries, such as storage-battery manufacturing, in which it is almost indispensable. The world will doubtless continue to call for more and more lead, but where the added supply is to come from it is difficult to predict.

Here is a call to the prospector in every part of the world to make an intensive search for new lead deposits.

Wanted: A New Moses

QUESTIONS of right and wrong are flying thick and fast nowadays in Washington—yet, curiously enough, no code exists which can be appealed to, either by the accusing group or by the unfortunate accused. We have the Ten Commandments, to which Jesus added the Golden Rule, the precept of willing payment of taxes and the command of altruistic love: but the complication of modern life brings up many problems in ethics whose exact answer has not yet been defined. May or may not a Cabinet official use the influence and prominence attained by his Cabinet appointment to step into a paying salaried job or a good law practice? Answer yes or no, reader: the answer must be yes or no. If no—say then, whether he must cut himself off from all his precedents, his training, and his acquaintances, and engage in something and in some group with whom he has had no contact for years? Our average ex-Cabinet officers of sixty or thereabouts would be apt to starve in many cases, if they took this view; and we would have to provide a government home for ex-government officials. Franklin K. Lane, leaving the Secretaryship of the Interior, took a job with the Sinclair Oil Co. at $50,000 a year. What did they pay him for—his ability or his influence and prestige derived from his former Cabinet job? The latter, we think. Did he do wrong? He did not think so: Franklin K. Lane would not stoop to anything his conscience condemned as unethical. Albert Fall, leaving the Secretaryship of the Interior, entered into the employ of the Sinclair Oil Co. What did they take him over for—his ability or his influence? His influence, we judge. Did he do wrong? We are on record editorially as believing that he erred. Here are some nice and sharp lines of distinction—the Teapot Dome, of course, made the difference.

May a Senator, Cabinet officer, or the President of the United States invest in securities while in office, and make a profit out of buying and selling? Daugherty bought and sold Sinclair oil—and other stocks—and his action has been considered by the Senate, the public, and apparently the President, as, by inference at least, improper. The terrible fact has been unearthed that Senator Elkins bought Sinclair oil. There were many thousands—perhaps hundreds of thousands—who bought and sold this and other stocks. Did he do wrong? We think not. Senator Elkins thinks not; and tells the jazz orchestra in the Senate to go to they know where.

Coming to mining, we have a committee on ethics in the Mining and Metallurgical Society of America, and another in the American Institute of Mining and Metallurgical Engineers. They have never been active—ethics is a subject we shrink from, for we do not know where we stand. How much better, however, it would be to have a code that we might stand by, and know whether we did right or wrong, and be enabled to speak frankly about our actions. We need a code for public officials and a code for mining engineers and mining companies. How did President Wilson acquire a fortune during his Presidential term? Did he save it out of his salary, or did he make fortunate investments? If so, in what: and who advised him? In any case, did he do right or wrong by accumulating a private fortune out of eight years of public service?

Recently a mining company passed its dividend, after bullish reports concerning the stock had been circulated. The mute evidence of stock market transactions was that somebody had known of the action of the company before it transpired and had sold in anticipation, buying in after the drop that followed the announcement. Somebody made a lot of money. If any of the officials of the company did this, did or did they not do wrong? Had they the right to? Answer, reader, yes or no: it must be right or wrong: there is no middle ground. It is done every day by officials of the big mining corporations. They think there is nothing wrong about it. What do the stockholders think? Another question: suppose our friend Jim Patterson, the manager of the XYZ mine, strikes a rich orebody. He wires the news to the directors. Has he a right to buy stock in the company in the open market? Answer, yes or no. Ethics and legality are two different things. There are a lot of things a man has the legal right to do which his fellow may consider him wrong in doing. We do not consider it compatible with the proper conduct of a mining journal that the men who have the editorial

management should be employed in other mining work, and paid by private mining interests. The Institute thinks otherwise; so does the *Arizona Mining Journal* and the *Northwest Mining Truth*. Which is right? Answer yes or no, reader: it must be yes or no.

The Geological Survey and the Bureau of Mines in Washington have their own codes of ethics. The good name of the Geological Survey is proverbial; the members may not engage in private work for pay within the United States, even during vacations or unpaid leave of absence. They may do so outside of the United States. The Bureau of Mines refuses to allow members to accept payment for articles written and published by them—on the ground that the knowledge was obtained in government pay. It is better to lean backward than to do anything which, while permissible in itself, may lead to unethical practices or the appearance of unethical practices. It has been common for mining engineers, after having been employed for a year or two by the Income Tax Division of the Bureau of Internal Revenue, to leave the Bureau and go into private practice, representing, before the Bureau, mining companies who are endeavoring to have their taxes adjusted and reduced. Are they right or wrong? Secretary Mellon, anyhow, has just ruled against the practice. We have heard rumors (unsubstantiated) of apparent collusion between tax officials within the Bureau and those who have graduated, and are appearing as attorneys before it.

It is time some new Moses wrote for us a rock-graven code, as to what is or is not permissible. Then we shall have less of gum-shoeing, less of slurring and reputation-besmirching.

Arbitration and Common Sense

THOSE who are interested in the rule of common sense will support the work of the Arbitration Society of America. This organization, formed in May, 1922, has the following purposes as defined in its charter: "To create, provide and maintain all lawful ways, means and facilities for conducting and effecting arbitration, mediation and conciliation and to establish chambers and tribunals for that purpose in the City of New York, and in other cities in the State of New York, and in other states and territories in the United States and in foreign countries; and to suggest, propose, designate, provide, nominate and appoint arbitrators, umpires, conciliators and mediators; and to establish and maintain branches, affiliations and agencies of the said corporation.

"To advocate, devise and recommend, and in all lawful ways to aid in bringing about in other states and territories throughout the United States, the enactment of legislation, such as has been enacted and is now the law in the State of New York and in other states, so as to universally establish arbitration as a legal, binding and effectual means of determining and adjudicating disputes, differences, controversies and misunderstandings, and to suggest and foster improvements in the existing law respecting arbitration.

"To foster, propagate, spread, popularize and put into practical operation the kindred doctrines of arbitration, mediation and conciliation; to print, publish and disseminate literature and other printed matter relating to any or all of the foregoing matters; and to do all other lawful acts to carry out the objects set forth therein, and thus to hasten the coming of that day of universal justice when right shall rule the world."

The society comprises among its members a long list of prominent individuals, firms, and trade associations, including the American Zinc Institute. Its methods have been approved by law in various states, and in New York State and in New Jersey decisions rendered under its auspices by arbitrators are legally enforceable without the right of appeal. In New York, moreover, an agreement of arbitration once entered into, one of the parties cannot withdraw if he sees things going differently from what he hoped. Having once put his hand to the plow of arbitration, he must turn the whole furrow.

In New York City the society has set up a tribunal which up to Dec. 1, 1923, had heard some five hundred cases, out of which a large number have been settled satisfactorily to the disputants in conferences preliminary to formal arbitration proceedings. The average arbitration required but a single hearing, and occupied but a few hours of the time of disputants, counsel, and witnesses. It is the custom to protect litigants from publicity, and no statements of the cases are given out, to the newspapers or otherwise. The society guarantees this privacy.

The "law's delay" is as demoralizing now as it was in the time of Shakespeare, so that the average wise citizen will bear many injustices and wrongs rather than be entangled in civil lawsuits; and the average honest lawyer has long had the habit of advising his client accordingly, his best function having been to keep him clear of lawsuits. The courts of New York are so choked with cases that it usually takes years to arrive at and settle a case, and if approached, the matter drags on tragically. Here, however, is an opportunity to settle differences legally and promptly. The docket of the society's tribunal for one day recently held twelve arbitrations. All civil suits may here be legally settled. Of course, suits in which the state is an interested party, such as criminal suits and those involving title to property, must be tried in the courts of the state.

Limitations of Placer Mining

THE COMMERCIAL POSSIBILITIES of deeply submerged gravels in existing stream beds of rivers that are known for their placer deposits have attracted the attention of mining men and others at various times. Wing damming and fluming were invented for the purpose of working such deposits. Dredging has also been successful where the physical conditions, presence of gold, and the absence of large boulders and irregular hard bedrock have been appropriate.

Some time ago several former sea captains tried out diving apparatus and the use of divers to investigate and work various potholes and deep portions of the Feather River, in California. After a trial of about three years, it is stated, further work has now been abandoned, as it was found that the method would not justify the expense required. This result might have been predicted, as it is evident that the work of a single diver is greatly restricted, and unless high-grade local deposits can be discovered and worked, the lower-grade gravel offers little inducement.

The established methods are applicable under favorable conditions and have the advantage of relatively

large per-man outputs as compared with the low output of a diver. Although the diver and his apparatus require a relatively small capital and comparatively small initial expense in preparation for work, this restriction upon output increases the expense to a prohibitive extent.

Another Good Newspaper Story Spoiled

THE ESSENTIAL FUNCTION of newspapers is to publish news, and we understand that Item No. 1 in the rules of the best newspapers is to make the story accurate. But lest specialization be carried too far, a fair amount of fiction now seems to be admissible, even in journals of good repute; and in the yellow press, particularly the Sunday editions, the actual facts of the news of the world are as subordinate as drugs in a chain drug store. The Associated Press usually confines its activities to news gathering, but it seems that even that excellent organization is not averse to branching out into the realm of hokum once in awhile if the story makes good reading and is unlikely to be checked.

A subscriber in Montana recently sent us a clipping from a paper whose name is unknown, but the clipping is attributed to the aforesaid A. P. It reads, in part:

Inventor Dies in Poverty; Family To Get Millions

Gold Extracting Method Finally Wins Recognition and Brings Wealth

(By Associated Press)

Lead, S. D., Jan. 3—A story of romance, centering on a former Black Hills figure, a story of a discovery which may revolutionize the gold mining industry. Harai Layng is the principal of the tale. He was a genius who chose to work with ores. For years his wife and mother lived in poverty while he sought to wring from nature's close reserve the secret of making almost worthless gold ores valuable. Finally he succeeded, but he did not live to share the wealth his intelligence and perseverance had loosed. He died March 24, 1922.

The good prince of the tale is C. W. Merrill. It was he through his Merrill company, that took the Layng process and put it into the channels of commerce.

The two women, bereft of husband and son, are now receiving royalties from the invention that, according to their attorney, will soon make them multi-millionaires. By an agreement made in the San Francisco superior court, they have been given their first installment, $7,500. This represents profits on royalties for a few days only, it is said. Their attorney states they will have $500,000 apiece before the first year is up.

Layng's method displaces the more expensive cyanide process of extracting gold. Its apparently proved success will make possible the rejuvenation of scores of "ghost towns" that infest worked-over mining districts of the West—deserted overnight when poor returns lent color to alluring reports of richer strikes elsewhere.

To Mrs. Benson, mother of Layng, the prospects of enormous wealth are pleasant, but not demoralizing to the poise of a lifetime. She is a graying woman, accustomed to derive her pleasures from the mind rather than external circumstances.

"Millions in the bank," she said, "are not worth as much as the deposit in your head that comes from good reading and fine thinking."

So the principal thing she plans to spend her money for is a garden of flowers. The back porch of the modest three-room flat in which she lives is a veritable hanging garden of plants she carefully tends.

Now, the one who sent us the clipping would like to know something about this process and what is claimed for it; and if all that has been said were true, we should certainly not keep our readers in the dark another day. Well, we are pleased to say that we have not been scooped. Mr. Layng published a description of his work in the *Engineering and Mining Journal* of Nov. 12, 1921, and both ourselves and the *Mining and Scientific Press* had published references to it previous to that date. During his lifetime, Mr. Layng did some valuable work on chloridization volatilization, for which broad patent claims were allowed. The Merrill company has also been conducting similar investigations, and to protect their work has taken over the Layng patents, for which it is understood $7,500 was paid, plus a small royalty when and if the process attains commercial success. So far the work that has been done is preliminary and at best the financial returns will be nominal. Thus "busts" another newspaper romance.

The Field for Invention

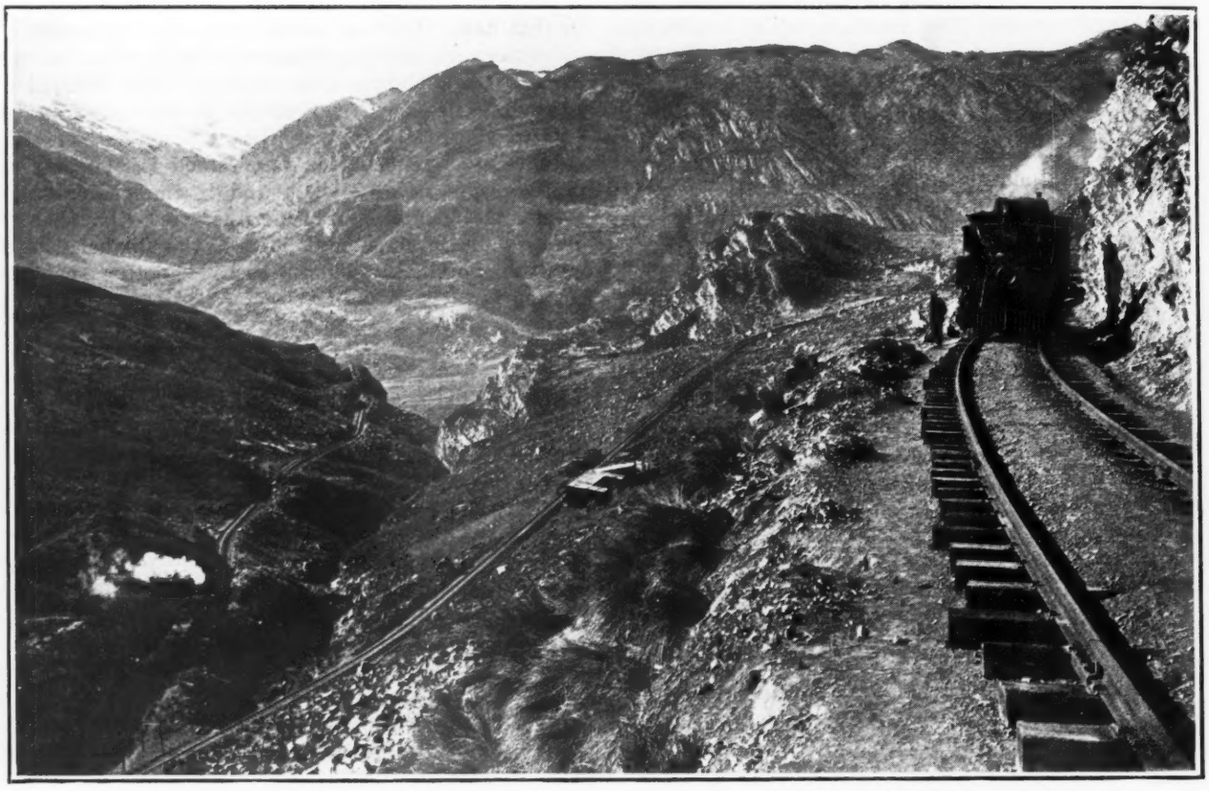
STUDY OF PATENT OFFICE PUBLICATIONS indicates the prevalence of the creative spirit, especially among those with a mechanical bent. Some of the inventions recorded hardly see the light of day; the great majority pass into oblivion almost from the moment of their announcement. A few have merit, although some in this class fail to reward their creators, because of adverse circumstances; the majority are composite ideas, indicating the quest for protection for some trivial detail as an insurance against attack by competitors. Many merely indicate misplaced energy. In the latter class we may include sundry crushing and grinding machines, each of which is heralded as marking a new era in ore dressing, by which vast improvements are presaged and costs relegated to insignificance.

It would be invidious to refer to any special machine in this class, but we cannot emphasize too strongly that the successful design of such equipment necessitates a broad operating experience and a mechanical knowledge well above the average. Several features in ball- and tube-milling, for example, suggest opportunity for improvement, and it is probable that modifications will be made in standard machines from time to time; but millmen wisely insist that a machine to be successful must conform to certain mechanical requirements. Spares must be obtainable without delay; it must be "foolproof"; the interior must be accessible; provision must be made for the easy renewal of liners; elasticity of output and scope for variation in the size of the product within certain limits are desirable; bearings must need little or no attention and must be out of range of splash—to mention but a few of the primary essentials.

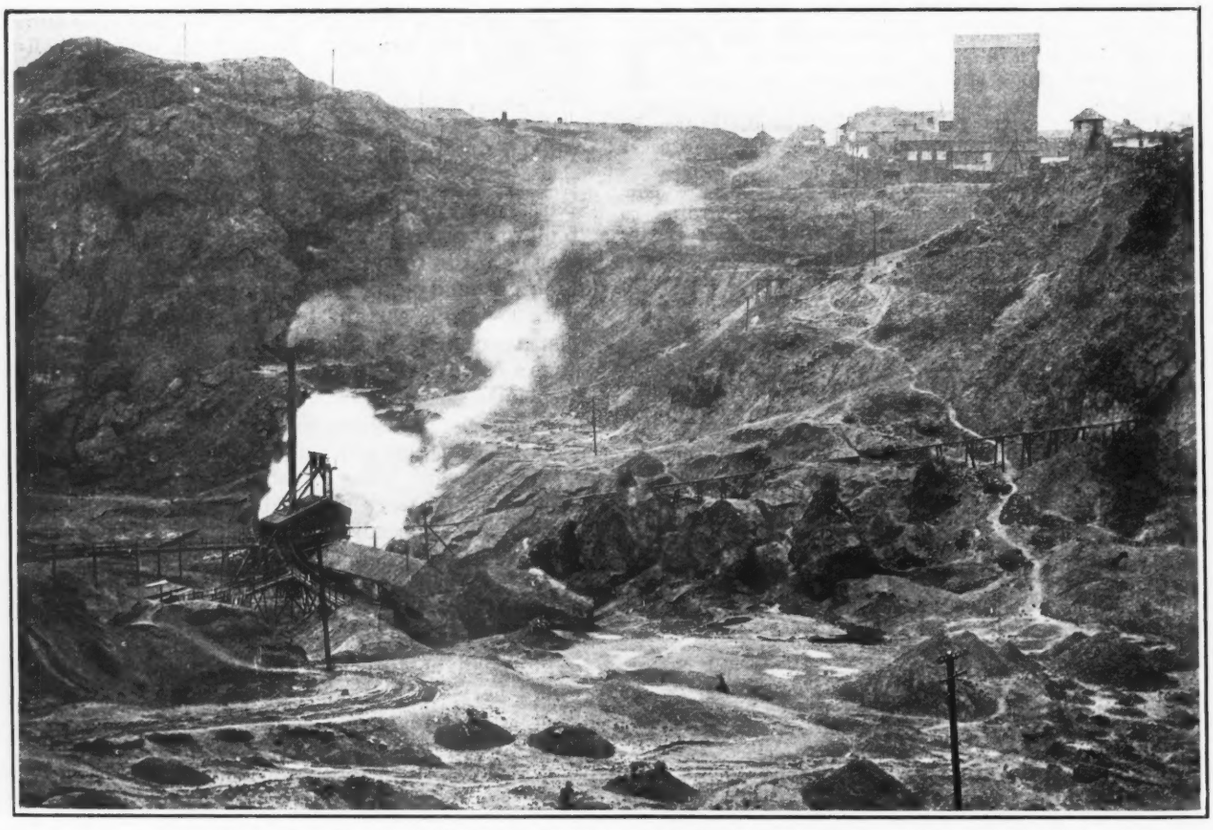
It may be reprehensible to discourage initiative of any kind, but there is ample proof that much energy and capital are being wasted in the "invention" of machines to do work that is being performed efficiently by equipment already on the market and in extensive use, the name of the manufacturer of which is sufficient guarantee that disaster, at least, will be avoided—which is more than can be said of many of the newer inventions.

The small operator needs an efficient machine; but usually he lacks the experience that would enable him to detect the danger of placing too much reliance on the claims of the enthusiastic inventor-manufacturer. The best test of practicability or efficiency of a new mill is whether or not it has passed the acid test of continuous operation on a commercial scale. Our columns are always open for the publication of operating results with new equipment.

In the Andes, in the Cerro de Pasco Region of Peru



Along the right of way of the Central Railroad of Peru. At the right, a passenger train. In the lower left, an ore train



An old shaft of the Cerro de Pasco company

What British Columbia Offers the Prospector

A Virgin Region for Mining Development in the Northern Part of the Province

By A. W. Davis
Mining Engineer, Kamloops, B. C.

AS THE SEARCH for new property continues in the North American continent, increased interest is being paid to the broad stretches of unprospected ground lying mainly in the northern part of British Columbia. In recent years the number of engineers investigating British Columbia has been increasing, and everything points to still further activity in this direction. Most of these men are from the United States, and their efforts, so far, have been crowned with a reasonable measure of success. In this article only what can be classed as "new" areas will be discussed, and the old-established districts, such as the Kootenays, will not be considered. Some of the more important finds in recent years are briefly described below.

At Dome Mountain, near Telkwa, on the Grand Trunk Pacific Ry., a series of quartz veins occurs, which veins, according to John D. Galloway, resident engineer for the district, belong to the filled-fissure type and partly to the replacement type. Recent surface work has shown up on the Jefferson property in this locality, according to this same engineer, a remarkable body of gold ore, covering, roughly, an area of 50x200 ft. Mineralization of the quartz with sulphides forms from 5 to 10 per cent of the mass. The ore Mr. Galloway considers primary. With regard to values he sums up matters, after giving a list of assays, by stating that there is a body of ore at least 30 ft. wide that will average fully $20 a ton in gold. This property, although it has been staked for some years, had never been considered seriously until a year or so ago, when a campaign of trench digging disclosed this ore.

Federal Company Has Several Properties

On Hudson Bay Mountain, between Telkwa and Hazelton, some very fine ore has recently been discovered on the Mamie and Henderson groups. On the latter high-grade gray copper is the predominant mineral. The vein is a fairly well defined fracture. There are generally one main band of ore from 1 to 2 ft. wide and several paralleling stringers. In places the whole working face, 4 to 5 ft. wide, is sufficiently mineralized to constitute milling ore, after the high-grade ore is sorted out. The vein occurs in volcanic rock, which varies from rhyolite to andesite. The metallic minerals are galena, zinc-blende, freibergite, and a little chalcopyrite. Eighty tons of sorted ore ran about 250 oz. silver per ton. Mr. Galloway, whose reports are quoted freely in the above description of this property, considers this ore to be of primary origin.

Both the Dome Mountain and Hudson Bay properties are now under bond to the Federal Mining & Smelting Co. This organization has also bonded two or three other properties along the Grand Trunk Pacific Ry. It would here appear to be a case of the early bird catching the worm. About 70 miles north of Kamloops, near Chu Chua, on the Canadian National Ry., what is thought to be an important discovery of gold ore has been made at the Windpass mine. This property was staked during the war.

There is a granite intrusion in the area, the core of which is Mount Baldie, lying a little east of the North Thompson River and the Canadian National Ry. The veins so far discovered lie in other rocks on the western contact of this granite. In the Windpass mine this rock is a diorite.

The main Windpass vein has a magnetite gangue. There is not much quartz in sight. In the higher-grade ore some native gold and bismuth telluride usually can be seen. This ore, probably primary, has a good chance of extending down a long distance vertically. The values are practically all in gold. Face samples, taken after every round in drifting 200 ft. along the ore shoot, on the only tunnel now in existence on the property, averaged $38 in gold, with an average width of about 4 ft. and with ore still continuing in the face. The wall rocks are often mineralized and, in stoping for mill feed, a greater width than this will no doubt be mined.

The glaciers are receding; that shown here will have disappeared in a few years

There are, of course, a great number of other groups of merit being developed here and there throughout the province.

The whole province, with the exception of some of the higher peaks, was covered by ice during the glacial period, and glacial drift in a great many areas obscures the surface. This feature, along with the general covering of timber, has greatly retarded the prospector. In recent years three railways have penetrated the interior of the province north of the Canadian Pacific Ry. About ten years ago the Grand Trunk Pacific Ry. was completed, crossing the province from the Yellow Head Pass in the Rockies to Prince Rupert, its port on the Pacific. The present Canadian National Ry. was completed soon afterward, opening up a new country from Tete Jeune Cache, on the Fraser River, to Kam-

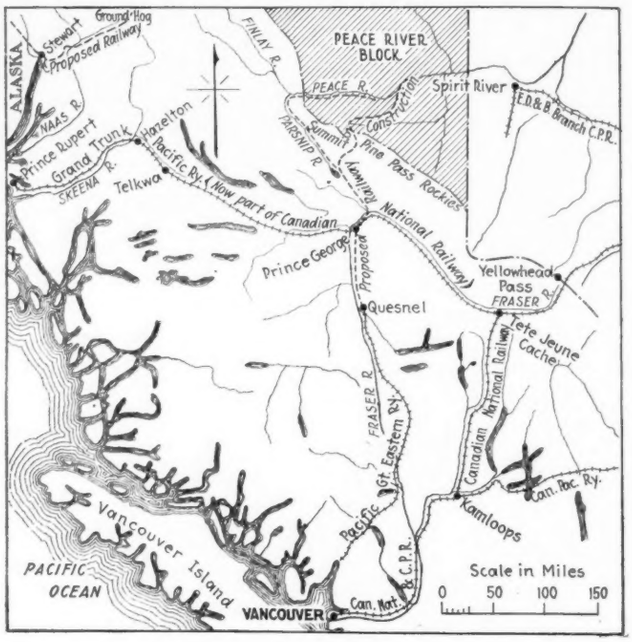
Cracks in the ice in which a railroad train could be lost are frequent in British Columbia glaciers

loops, on the main line of the C.P.R. Finally the government-owned Pacific Great Eastern Ry. was built, extending from Vancouver to Quesnel, a short distance south of Prince George, a point on the Grand Trunk Pacific Ry.

In an endeavor to make clear the situation in connection with the search for new mines, the routes of certain railways, which, the chances are, will be built before long, are indicated on the accompanying map. These, obviously, are good places to prospect and to develop any favorable showing. A good lead mine about 200 miles from a railway is useless; but if, on the other hand, it is located near the route of some projected road, there is some incentive to go ahead.

Shown on the map, in the northern part of the province, is what is called the "Peace River Block." This is a fertile area and a big potential wheat producer. There is considerable agitation now for a railway connection with Prince George and Vancouver, which is sure eventually to become a great wheat port. The approximate location of such a road is shown on the map. Along this route any ore which is developed has a good chance of getting transportation before long. There are stories of galena in quantity occurring in this area, as well as other minerals. An alternative route that is being considered follows the Parsnip to its junction with the Peace River, and thence down the latter.

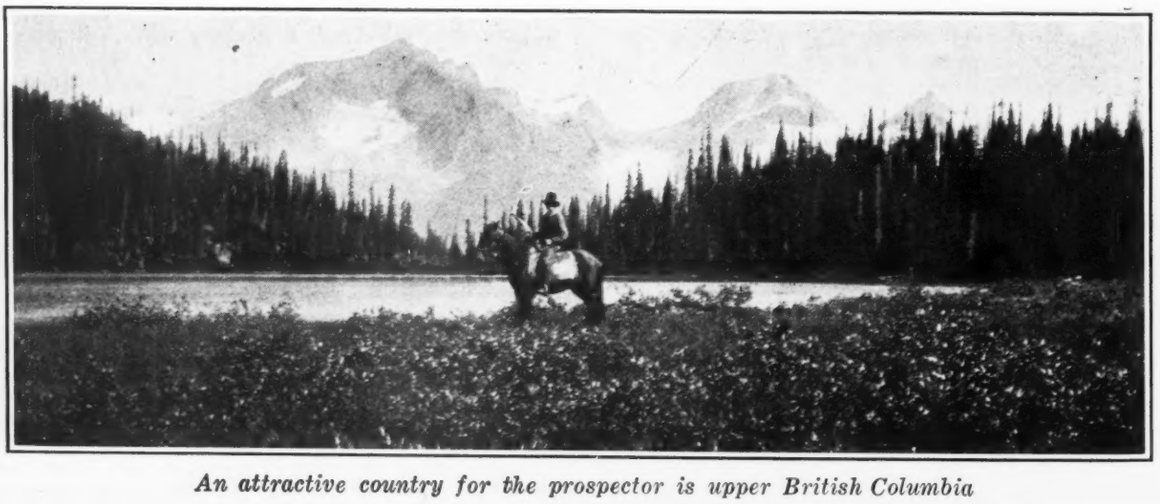
About 100 miles northeast of Stewart, in the Ground Hog country, occur some extensive semi-anthracite coal fields. Two routes have been discussed for a railway to this area. One of them in from Stewart, at the head of the Portland Canal, over the Bear River summit and thence up the upper Naas River to the coal field. The other is from Hazelton on the G.T.P. Ry. up the Skeena River. The well-known Premier mine is above Stewart, and the mineral possibilities of the country that would be traversed by this road are good.



Map showing proposed new railways in British Columbia

The projected roads, described above, are all the railways under consideration at the present time, the odds being in favor of the Prince George-Peace River Block road being built first.

There has been too much of haphazardness in connection with the investigation of the mineral resources of the North. Individual properties are looked into from time to time, but systematic investigations by the big operating companies have not been frequent. There is one exception to this rule—and that company seems



An attractive country for the prospector is upper British Columbia

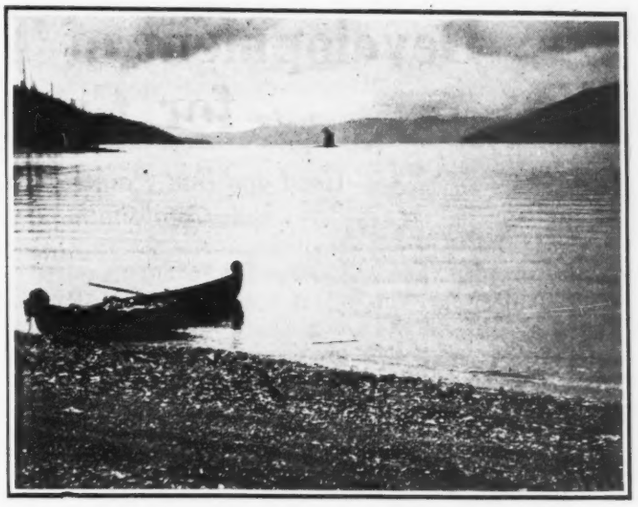
to be doing well. An exploration company with capital enough to justify a campaign of several years should have a good chance of a successful career in this northern territory.

An engineer covering a certain area for a season should carry an assay outfit. The predominant values are often in gold, and a quick way of determining values on the ground is not to be despised. Moreover, neighboring prospectors bring their ore to determine its value, and a great deal of information is often obtained in this way with little effort.

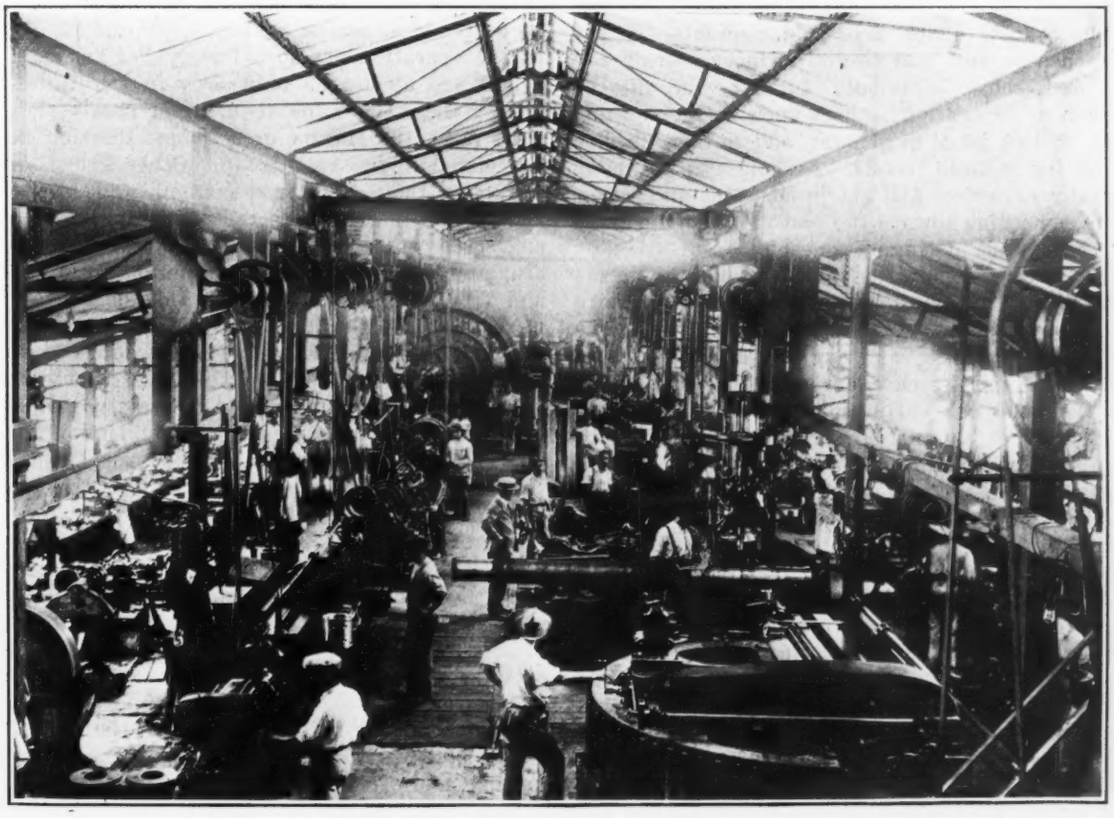
The British Columbia coast, with its innumerable inlets, is likewise an attractive field for the prospector, and many a stream, penetrating deeply into the mountains, has been visited by only the occasional hand logger or trapper.

Charles Camsell, of the Canadian Geological Survey, says that although the geological maps of the western part of British Columbia show the Coast Mountains to be made up of a great mass of eruptive rock, mainly granodiorite, such a simple condition does not really exist. Occurring in the granodiorite there are, he states, here and there, remnants of its old cover of stratified rocks, the contacts of which with the eruptives are more or less mineralized and favorable for the occurrence of metallic deposits of copper, lead, zinc, gold, and silver.

Equipped with a good motor boat, a great deal of territory can be covered in a season. Inlet after inlet can be explored, and, where no prospectors were found, very often valuable information could be obtained from trappers or other inhabitants of the locality. A journey of this kind has much to commend it, with fish and game plentiful, apart from its prospecting possibilities. One of the main points in its favor is the enormous territory of largely virgin ground which can be examined without getting more than a few miles from tidewater.



Quesnel Lake, looking west



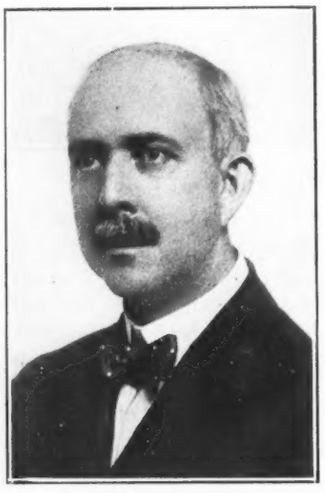
Machine Shop at the St. John del Rey Mine in Brazil

On account of the isolation of the property heavy repairs must be made at the mine. Native mechanics do the work

Development of Treatment Methods for Complex Ores

Good and Bad Points of the Processes Devised to Treat Combinations of Lead, Copper and Zinc Minerals

By R. G. Hall
Consulting Metallurgist, San Francisco, Calif.



R. G. Hall

FROM the earliest days the problems of treating complex ores have existed; but the definitions have changed as progress was made. Recently ores have been successfully treated that the past generation rejected as worthless. The actual accomplishments, however, leave many gaps to be filled, and there are still some complex ores. In this article, consideration will be restricted to the ores of the non-ferrous metals, and more specifically to those of value for their lead, zinc, copper, silver and gold contents. Other elements, such as iron, may be and in fact generally are present, and these contribute further difficulty to the problem of separation; others such as arsenic and antimony, though small in amount, add to the difficulty of refining the reduced metals. Arsenic and antimony are generally nuisances and yet in some instances they contribute something toward the cost of removing them and have been made at times a source of profit.

What is a complex ore? Not long ago the terms "refractory" and "complex" were used frequently more or less synonymously, but they are not of the same shade of meaning. The early-day miners of Colorado, in Gilpin and Clear Creek counties, used stamp mills. At first the gold was easily collected in the mortars and on the plates by mercury. With greater depth in the mines, more and more of the gold was retained by the sands from the plates. It was associated with the sulphides, which did not yield the gold to the mercury. The ore became refractory. Later the same district became a producer of ores containing lead, copper, silver and gold. The metals from these ores under proper conditions can, by a series of related processes, be recovered satisfactorily. But zinc was soon added and this constituent in such a mixture originated the term "complex." The ore could no longer be treated and the clean metals recovered by a simple series of related processes. Zinc introduced complexity. Other constituents might give rise to complexity in these ores, but among the non-ferrous ores the foregoing are pre-eminently the most important.

The various mixtures that may be encountered include sulphide ores of the following types: Class I, a mixture of galena and blende in more or less gangue; Class II, galena, pyrite and blende, in gangue; Class III, chalcopyrite, pyrite and blende in gangue; Class IV, pyrite and blende in gangue. It is evident that lead ores and copper ores, either together or separate, and with or without silver and gold, are not classified as complex ores; nor are the ores of zinc minerals associated only with gangue.

Class I apparently represents the simplest of the complex ores. Many of the ores coming in this group hardly deserve the term of complex; for example, the ores of the Tri-state district, Missouri, Kansas and Oklahoma. Galena is present in some instances in large amount in these ores, and in most of them it is present in sufficient amount to add materially to the mine operators' revenues. However, these ores are so simple in their physical structure that the lead and the zinc minerals are broken free from each other and from the gangue by relatively coarse crushing, and separated by ore-dressing methods of a simple character. The galena is concentrated into a product that is over 90 per cent clean, and on the same machine the blende is recovered in an almost equally clean product. The losses in the operation are surprisingly low for both metals. These are about the only ores in the United States having these two minerals alone or nearly alone.

In Asia, the Burma ores in one district alone may be classed in the first group. Other known orebodies, owing to their high iron content, fall into Class II. In the one district referred to, however, the physical character of the ores is such that only the very finest crushing will separate the minerals from each other and from the gangue. When this degree of fineness is reached, the resulting pulp is too fine for concentration on gravity machines. The ores of Broken Hill, in Australia, are grouped in this class, notwithstanding the presence of some pyrite. Gravity methods were sufficient to partially separate the galena of these ores, but the blende, together with some galena and the gangue, was left to be treated later. In Africa the ores of the Rhodesia-Broken Hill district, now an important source of lead, also fall into this class. As yet not much work on a commercial scale has been done upon the separation of the minerals in these ores.

Class II includes the greater number of the ores usually termed complex, although, as shown, the ores of some very important fields are excluded from Class II and relegated to Class I. It is understood that copper minerals may be associated with the pyrite, as well as the silver minerals that are sometimes of low specific gravity, and often very friable.

In the United States Class II will include many of the Leadville ores once shipped to the lead smelters and the zinc content wasted; also many of the ores of the Tintic, Park City, and other districts of Utah; large bodies of ore, some that have already been mined and many that remain to be mined, in the Coeur d'Alene

district of Idaho; most of the zinc ores of the Butte district, and lesser but important ore deposits in many of the mining districts of the Rocky Mountains.

In British Columbia one important orebody of this class is now being worked, as well as numerous small but valuable deposits. Many deposits are in Mexico; some well developed, notably those in the districts tributary to Parral, that will produce a large tonnage in the near future.

In Asia, there are notable deposits. However, they are far from transportation.

Owing to the present scarcity of lead ores in the United States it is probable that more attention will be paid to the complex ores with the object of supplementing our diminishing lead supplies, and, perhaps, in the not so very distant future, of supplementing the supply of zinc which may begin to diminish in the Tri-state field.

In Europe, in the Harz and elsewhere, the once great deposits are now largely exhausted. The reduction works of those districts were for a long time schools for the metallurgists who afterward became our mentors in the United States. Zinc volatilization for its oxide, by means of reverberatories, and the smelting of lead-zinc ores requiring high-zinc slags were practiced at Frieberg long before such practices were necessary on this side of the Atlantic.

Class III ores are not common in the United States; at least there are no orebodies or any deposits entirely or substantially free from lead, with copper and iron present in quantity, that promise to produce such tonnages as are represented in the previous classes. Some deposits occur in Arizona and New Mexico, and in northern California there are deposits of commercial size. Lead is seldom entirely absent, but where lead is only a fraction of 1 per cent and copper is considerably more, the lead can very well be sacrificed in obtaining a better recovery of the major metals, zinc and copper. This class is important as it lends itself to more direct treatment than the previous classes, and in some cases a zinc product is yielded having a value in excess of the value of the metallic zinc content alone.

Class IV, pyrite and blende, has its chief representative in the Wisconsin district. The New Jersey field, represented by oxidized rather than sulphide ores, may be included here, as two important methods of treatment were developed that have been widely extended into other fields—the Wetherill grate for making oxide direct from the ore, and the electromagnetic method of separation. A few mines in the Tri-state field have also produced concentrates containing too much pyrite for profitable treatment in the retort without previous removal of the pyrite. Some of the Leadville zinc ores were nearly lead-free, and occasionally small amounts have been found elsewhere, but for the most part such ores, unless containing an appreciable precious metal content, are of small value, except in the two districts referred to. The pyrite of the Spanish mines in Europe contains sufficient blende in some parts of the orebodies to invite subsequent treatment for the zinc.

Only sulphide ore has been included in the classification. The franklinite and willemite ores of New Jersey have been made an exception as the methods of treatment are of special interest. Generally the oxidized ores of zinc, and mixed ores (oxides and sulphides) do not lend themselves readily to the methods of concentration applied to the sulphides, and such ores are not of interest here, except in the one instance cited. All of the complex ores within the scope of this paper fall into four classes; therefore, in considering the ore-dressing methods, or metallurgy, for each class, I will mention the special processes that have been tried in the past on certain typical ores, the causes of failure where there has been failure, and the progress of the art that has made the waste heaps of other years the source of a large metal supply.

AS THE SUPPLIES of simple high-grade ores become exhausted, methods must be devised to treat the more complex ores of lower grade and to recover metals that were formerly wasted. Much attention has been given to this subject recently. In this paper Mr. Hall classifies the common mineral combinations that go to make up what are known as complex ores and reviews briefly the development of metallurgical methods to treat them. A supplementary paper on volatilization, also written by Mr. Hall, will soon be issued by the Institution of Mining and Metallurgy, of London. The author is well known as a student of these problems and was formerly resident manager of the Burma mines, in India.

The ores of Class I do not, in themselves, present special problems that are not encountered in the succeeding classes, especially Class II, so these two groups will be considered together. The separation of galena from blende does not present special difficulty, except where the mineral association necessitates very fine grinding. Where such mineral association exists, the extraction of the individual minerals by taking advantage of differences in specific gravity will not present problems of the same degree of difficulty as where pyrite and chalcopyrite are also present. Classes I, II, and III will therefore be considered together so far as they have problems in common.

The separation of the metallic minerals from the gangue minerals in any combination that may be present presents no small difficulty. The specific gravity for the metallic minerals is: Galena, 7.5; pyrite, 5; pyrrhotite, 4.6; chalcopyrite, 4.2; and blende, 4.1. For the gangue minerals: Barite, 4.5; garnet, 4.4 to 3.4; fluorspar, 3.2; and quartz, calcite and similar minerals, 2.6 and upwards. It may be thought such a mixture, where the minerals exist in any important amounts, seldom occurs, but I have in mind an ore that contains as major mineral constituents, pyrite, chalcopyrite, blende, and galena, and the gangue minerals gypsum, anhydrite, barite, calcite, quartz, and rock silicates, all intimately crystallized. Such a mixture is not unusual in the Rocky Mountain districts. Where the ore has been crushed to such a fineness as to free the minerals from each other and from the gangue, classification, or separation of the minerals by recourse to specific gravity differences, is quite impossible. A more or less imperfect separation of the heavier minerals can sometimes be accomplished by careful stage crushing, preceding gravity concentration. A part at least of the

galena, where present in commercial amount, can be recovered and a part of the lighter gangue can also be rejected. Unfortunately all available fine-crushing machines are of a non-selective type, and cannot be made to crush only the coarsest particles, or to crush them to just the right size and then to discharge the material. This can be accomplished more or less imperfectly by stage crushing. In the process of stage crushing, ores are quickly and frequently removed from the crushing machine, and screened or classified, the coarser particles being then returned to the original machine, or to another machine for further comminution. Where the grinding has to be carried to extreme fineness, as with so many complex ores, the larger portion of the ore will have been comminuted to such a degree as to make gravity separation inapplicable. However, it is in these extremely small sizes that the more modern methods of concentration have made the most progress.

A review of the methods of concentration, including

Concentration Methods That Have Had Most Influence Date From 1900

the appliances in use previous to about the year 1900, is of special interest, as these concentration methods which have had the greatest influence on the metallurgy of the more amenable ores date from that time. The use of jigs, or machines that operate upon the principle defined by Richards as "hindered settling," had long been known for the coarser sizes; tables, having a more or less modified flat top, and a reciprocating or panning movement, were used for the sizes too small for the jigs; and the vanner, which had been invented subsequent to the table and jig, treated the sizes too small for the tables. The slime was imperfectly handled by blankets, tables, buddles and other appliances and thus some concentrate was recovered that would otherwise have been lost. However, none of these machines was designed to give more than one concentrate, or to make separation of minerals having a specific gravity difference of less than one.

The earliest attempts at milling complex ores were made to recover the lead. Fortunately most of the silver was associated with the galena. All of the mineral crystals were by no means so fine, nor were the minerals so closely intermixed, as they are in ores to which metallurgists have later become accustomed.

Gravity methods of concentration have failed to give satisfactory results on most of the important mixed orebodies of the world and metallurgists endeavored to find the solution by chemical means. Chemical experiments were being carried out in Australia and in Europe, chiefly on Australian ores, and, in America, on the ores of the Rocky Mountains. The experiments followed similar lines in all countries, but, owing to the status of the chemical industry in Europe, the greatest efforts were made there. The proposed processes were of extreme interest, and many promised to solve the problms of the complex ores; but not one of those based solely on changing the chemical condition of the zinc proved to be sufficiently valuable to be generally adopted by the industry. The present methods of electrolytic recovery, which are chemical, are excepted and are discussed further on in this article. The electrolytic methods came into use at least fifteen years after the period under review.

A brief summary of the principles tried out is of interest. It would be impracticable to discuss all the proposed processes. A perusal of the patents issued indicates that many of the processes existed only on paper and had never even been tried in the laboratory. Hundreds of patents have been issued based upon chemical principles known to chemists years before. They differed from each other only in the language used to describe the same reactions and processes.

The most obvious method of removing zinc from the other valuable constituents and from the gangue of the mixed ores is by conversion to the soluble sulphate. Lead sulphate is insoluble; silver and gold under similar conditions are also insoluble. Copper will be dissolved under the same conditions as zinc, but it was usually a minor constituent in the ores which were then known or being treated. Many proposals were made for roasting the zinc to sulphate, the usual cause of failure being attributable to the fact that the roasting temperature of zinc sulphide is close to, or actually above, the dissociation temperature of zinc sulphate. A method to overcome this difficulty has recently been worked out, and a plant has been constructed at Durango, Colo. Judging by the care that has been taken and its sponsors, the process may result in solving the troublesome problem.

Zinc sulphide can be roasted to oxide, which is soluble in sulphuric acid and other reagents. Some iron will also probably dissolve but this is not material, as ferric iron can be removed readily from a solution of zinc sulphate. When iron is present in zinc sulphide ore the zinc oxide after roasting is not all soluble in acid of ordinary strength. The insoluble portion is in a form usually known as zinc ferrite. The amount is proportional to the iron present, but it also varies with the temperature of roasting, the time required by the roast, and the intimacy of the mixture of zinc and iron sulphides. The amount may be controlled within limits, but, so long as iron is present in a condition to combine with the zinc in roasting, no practical method has yet been found to prevent the formation of some ferrite. It is possible that the new method of roasting referred to before will be able to overcome this difficulty.

In the absence of iron, or low percentages, it is possible to roast zinc sulphide without the formation of ferrite. Lead, however, in an amount such as is present in the Broken Hill ores is also detrimental, for at the high temperature necessary to finish the roast the lead oxide and sulphide are in danger of fusing and even of reacting with each other. Trouble in the subsequent lixiviation of the zinc would consequently result.

After the zinc was in solution the problem was not by any means solved before electrical precipitation was developed. The demand for zinc sulphate was very small; precipitation by means of an alkali was too expensive, and but little less expensive by magnesium hydrate. Both lost the sulphuric acid, or practically so.

Chlorides Also Used in Experimental Work

Other investigators were meantime working with the chlorides. Three possibilities were considered. (1) *Conversion of the sulphides to chlorides in the wet way* either by chlorine, by a chloride salt, or by hydrochloric acid.

A process typical of this method was the treatment of zinc-bearing pyrite cinder containing 10 to 12 per cent zinc. The process was carried out in Westphalia on a commercial scale, beginning about 1892. The cinder was given a chloridizing roast with salt in a muffle furnace at a temperature of about 600 deg. C.

The zinc chloride was leached out, resulting in a residue containing 1.5 per cent zinc. The sulphate of soda in the solution was removed by refrigeration, and after purification the solution was electrolyzed.

When zinc and lead sulphides are treated under proper conditions with hydrochloric acid, the galena is attacked in preference to the blende or the pyrite. The reaction has been the basis for a large number of processes, none of which have been commercially applied. When galena and blende are treated with a solution of ferric chloride, the galena is changed to lead chloride before the blende is affected. This has also been made the basis for a number of patents and processes, none of which got beyond the laboratory.

When a mixed ore is subjected to a low roasting heat under certain conditions, the galena is readily converted into lead sulphate, which is soluble in hot brine solution. The silver is also dissolved when salt has been added to the roast. The tendency of the silver chloride to revert to the sulphide in the presence of blende is marked, and various means have been resorted to to prevent this. Certain applications of this method are now being made and promise to be successful.

(2) *Conversion in the dry way.* When dry chlorine gas is passed through or over mixed sulphides of zinc, lead, and iron, the metals are converted into chlorides, zinc and lead completely and iron incompletely; silver and gold are also attacked. Under certain temperature conditions sulphur chlorides will form, but this is easily avoided. The metallic chlorides are all soluble in hot brine. Ferric iron is removed from the solution by zinc oxide, and the other metals by fractional precipitation, leaving the zinc chloride solution nearly pure. Electrolysis of the zinc chloride solution has been attempted but has not met with much success. The use of closed diaphragm cells has been a stumbling block. The electrolysis of the dry fused salt is feasible, but the voltage required to maintain the temperature of the cell above the melting point of zinc has been too high hitherto for commercial work except in special cases. Obviously the chlorine derived from the electrolysis of the zinc chloride would be available for reuse and a cyclic process would result.

When a mixture of galena, blende, and pyrite is stirred into fused zinc chloride, the zinc chloride will convert the lead and silver into chlorides, and the zinc chloride is thus converted into a sulphide. This has been the basis for many processes.

Ammonium Carbonate a Good Solvent for Zinc Oxide

Another process of considerable interest depends on the solubility of zinc oxide in a solution of ammonium carbonate. The principles underlying this process are substantially those used in the recovery of copper from certain low-grade tailings, but so far it has not been put into commercial use for the recovery of zinc. The preparation of the ore and the roasting is the same as for the solution of the zinc oxide by sulphuric acid. After solution the residue is separated from the dissolved zinc in the usual way. Ferrous iron compounds, copper, arsenic, antimony and many other impurities are as readily soluble in an ammonium carbonate solution as in sulphuric acid and must generally be removed to obtain a pure zinc oxide. Dissolved ferrous compounds must be oxidized, and can then be removed, although this is not accomplished without difficulty. The reducible metals are readily precipitated by zinc dust. After purification, the zinc is precipitated by distilling off the ammonium carbonate. The precipitate is a basic carbonate. The solvent is recovered by condensation in water, and is available for further use, except for that portion of the carbon dioxide which combines with the zinc oxide. This can be recovered by heating.

This process offers possibilities where the price of fuel is low and electrolysis is impracticable. The precipitated zinc oxide would not have a wide use, as it is not of value for pigment without further treatment. Bretherton (*Trans.* A.I.M.E., Vol. XLVII) has experimented with the mixed ores of California, and found that a fair extraction could be made. Hofman gives data on solubilities that may be of interest, as attempts are being made, from time to time, to revive interest in the use of this process.

Volatilization of Importance for Jersey Ores

Probably the most important of all the methods used, or suggested for the treatment of the mixed and complex ores, was that based upon volatilization on the Wetherill grate, afterwards extended to the blast furnace and the reverberatory. The manufacture of oxide from the oxidized ores of New Jersey had been undertaken as early as 1850. Soon after this, Samuel Wetherill perfected his grate and the complete process, which has been since known as the Wetherill process. The use of fabric filters for the recovery of zinc oxide, a necessary supplementary feature, was known for some time before the Wetherill process was applied. The fabric filters as utilized in the baghouse were developed later and have been generally identified with the name of F. L. Bartlett.

The complex ore problem has now been reviewed to about the beginning of 1900. Gravity concentration was the only known means of ore dressing. Machines for the finer sizes failed to recover high percentages of mineral, and the finest sizes were practically untreatable.

Two machines and a new process changed the aspect of the problem. These came into general use within the decade succeeding 1900, and were: (1) The Wilfley table; (2) the magnetic separator; and (3) the flotation process. The two machines were in use before 1900 but had not made much progress.

The Huff electrostatic separator also found and still finds some application in separating blende from other minerals. This machine, or one involving the same principles, was used for a time on the Wisconsin ores. The wet concentration product contained too much marcasite for the zinc retorts. The minerals are coarsely crystallized, and the removal of the iron by magnetic separators is easily accomplished. A Huff machine was first used, but appears to have been abandoned later in favor of roasting and the use of a low-tension magnetic separator.

Flotation of Great Importance

The last marked advance in methods for concentration of ores, the flotation process, was revolutionary. The policy of the exploiters of the flotation patents was responsible for delaying the widespread use of the process in America for at least ten years, and the secrecy, necessarily a part of that policy, long prevented full understanding of the many applications later shown to be feasible. Nevertheless the process freed the art of ore dressing from dependence upon the physical property of specific gravity. As a corollary, slime is no longer, as formerly, passed out of the back door

of the mill and wasted. On the contrary new machines for finer crushing are being invented and the practice of fine grinding has proved to be advantageous for many ores. However, flotation has not contributed in America, excepting one district, a large amount of zinc concentrate, either from the complex ores of the West or the simple ores of the Tri-state field. A zinc ore occurs in the Butte district that is being treated by the process. The ore can be crushed fine enough to free the mineral, and by flotation a high-grade zinc concentrate is made. However, the value of the silver in the concentrate is half the zinc value of the concentrate at the mill, and the silver requires a subsequent treatment at an added expense for its recovery. Where the base metals, other than zinc, are high, as in other parts of the Butte district, flotation is used to make a concentrate that can be handled to greatest advantage by the electrolytic process for zinc recovery, which is fortunately available there.

In other parts of the United States attempts have been made to treat certain complex ores by means of selective flotation, but, as far as I know, without commercial success on any large scale. In British Columbia, selective flotation in conjunction with the zinc electrolytic process is successful in the treatment of a complex mixture of sulphides.

The failure of the metallurgists of the Tri-state field to utilize flotation to any greater extent finds explanation in the ore itself and not in any lack of enterprise. The mineral particles are coarse and not intimately associated with the gangue. A reasonable recovery at a low cost can be made by jigs and tables. The mills are therefore cheap to build and operate. The addition of tube mills and flotation machines would double the operating cost and more than double the initial cost of the mills. Ore in the ground is the cheapest raw material in that field, as the operator does not generally own the ground but only pays royalty.

The flotation process has not been employed in the treatment of complex ores in America to the extent that it has been used on the simpler ores of copper and lead. To date, selective flotation has not been used to any great extent commercially, though much promising experimental work is now going on.

Electrolytic Methods Now Being Applied

The electrolytic deposition of zinc on a commercial scale is modern, but the conditions necessary for its success were known long ago. There was never any difficulty in depositing zinc from an electrolyte of pure zinc sulphate. The quantity deposited per unit of current was known, and the voltage was readily determined by experiment. There were nevertheless a number of obstacles preventing commercial application of the process, and some of these exist yet, except in certain localities. The cost of power remains a ruling factor. The tank consumption of electrical energy is not far from 1.5 to 1.7 kw.-hr. per pound of zinc produced and marketed. To this must be added, when using central-station power, the step-down and rectifying losses and the conductor loss for the low-tension current. These factors add not less than 20 per cent, giving 1.8 to 2 kw.-hr. per pound of zinc. The precise quantity is dependent somewhat on the amount of money invested. When central-station power was worth from one to two cents per kilowatt-hour at points where freight rates and ore supplies might permit the application of electrolysis to zinc recovery and with zinc selling at five cents per pound, the return was not promising.

Previous to 1900 there was no economic necessity in the United States for the use of other than the simple ores of the Middle West. Since then other ores have been used, those of the Rocky Mountain districts having presented the greatest obstacles to the use of the electrolytic process. It was early recognized that zinc in complex ore containing iron would be found to be difficultly soluble in dilute acid when roasted. The iron is often intercrystallized with the blende and almost always fine grained, a condition conducive to the formation of zinc ferrite. This difficulty has not been entirely overcome. It has been minimized by better control of the roasting conditions, but it is still a factor, and electrolytic zinc reduction is successful in certain places in spite of it, and not because it has been removed. Whether roasting the mixed ores to form zinc sulphate will remove the difficulty remains to be seen. It seems probable that it will have some effect, although it will introduce new conditions affecting the recovery of zinc by electrolysis.

The standard methods for the purification of a solution of zinc sulphate need not be discussed here. The fact that ferric hydrate, when precipitated from a solution of zinc sulphate, will carry with it certain metals and metalloids which interfere with the subsequent electrolysis, was rediscovered early in the application of the process. Hence iron, which all experimenters had been endeavoring to keep out of the solution, was needed in it. If absent it must be added and then taken out again.

There is not on the American continent, nor so far as I know elsewhere, any commercial production of electrolytic zinc by steam power. However, conditions may arise in certain places that would make appropriate the use of power generated from carbonaceous fuel. Paradoxical as it may seem, such conditions are more possible (I do not say probable) with 60 per cent zinc concentrate than with the 40 per cent material, unless the latter contains other metals of material value. In a roasted Joplin concentrate containing 90 per cent zinc oxide and only 1 or 2 per cent of iron the loss due to insolubility of zinc will be low. Consequently since the roasting loss would be practically the same in both cases, the electrolytic method may be expected to recover at least 100 lb. more metal per ton than the retort method. The extra metal recovered might under favorable conditions pay for the extra cost of the electrical current and leave a profit. With the 40 per cent ore containing iron, the recovery by the electrolytic method probably would be less than by the retorts. The higher the price of zinc the greater becomes the disadvantage of applying the electrolytic method to low-grade iron-bearing zinc concentrate.

With a fume or oxide produced by a Wetherill grate, blast furnace or reverberatory, the solution purification difficulties are diminished. Such impurities as nickel and cobalt, that are removed from a zinc sulphate solution wiih difficulty, do not here occur at all, as they remain in the matte. The zinc in a fume is more readily soluble than in a roasted ore, and it is unnecessary to break up iron compounds. Arsenic, antimony and cadmium are removed in the same manner in both cases; the iron required for the purification of the solution must be added. Certain fuels containing small amounts of chlorine have given trouble, and additional precautions are necessary to meet this condition which are unnecessary with roasted ores.

It is also evident that the calcine of an ore contain-

ing considerable copper entails an extra expense in the purification of the solution. Zinc dust is used for the removal of copper from the solution, and may cost more than the value of the copper recovered. Zinc oxide made by smelting and fuming avoids this difficulty.

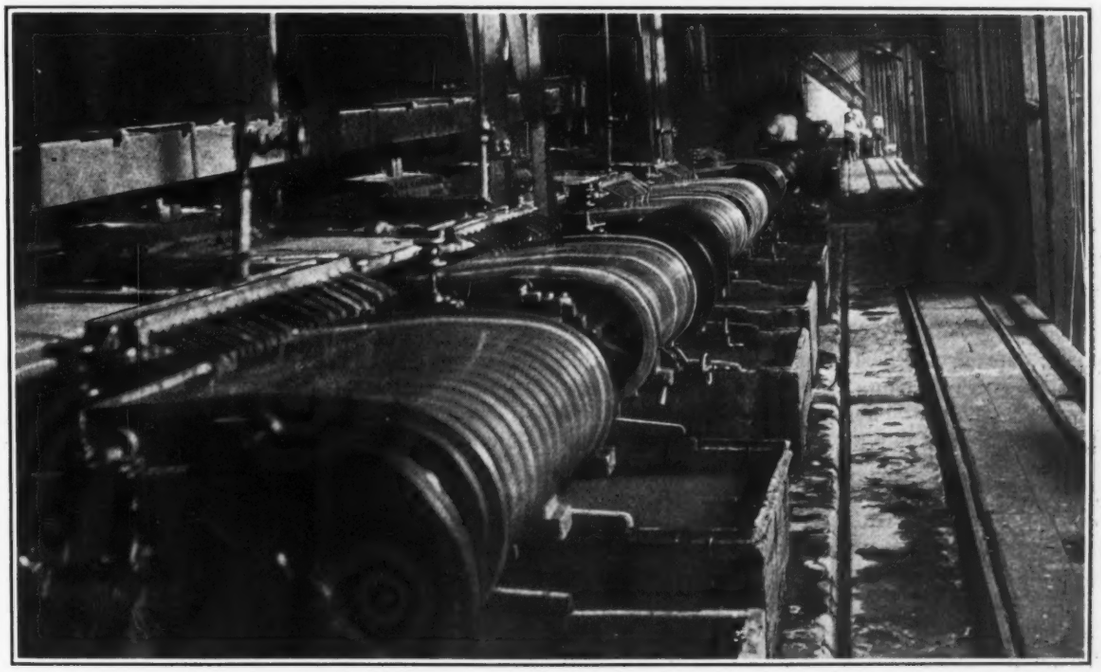
Valuable experimental work has been done in electrothermal methods and apparently favorable results have been obtained by careful investigators. There is only one example of its application and this is where electrical power is available at a low cost. The most promising work on the complex ores has, as its objective, the recovery of the zinc by distillation, and the smelting of the residue in the same operation; the lead being obtained as base bullion, and copper, where present, as matte. The current consumption observed in the experimental work was said to have been favorable, and the zinc was condensed without any great difficulties. The process never advanced to a commercial stage in America. Professor Fulton (*E. & M. J.-P.*, July 1, 1922, page 8) in his most recent work experimented with a coked briquet, made from the roasted ore, coke and a bituminous binder, as a resistance element in the furnace. The temperature was readily controlled. The residues were not smelted; but subsequent smelting would be necessary if they contained recoverable values. It is probable that this method might be of more value for the recovery of zinc from the high-grade ores than from the complex ores of low zinc content.

Methods of treatment based on the volatilization of chlorides have not come into practical use for the treatment of the complex ores. Experimental work indicates that lead, copper, silver, and gold can be readily volatilized as chlorides and thus separated from zinc. Individual instances may arise where advantage can be taken of this principle. The theoretical and most of the practical details have been determined.

In summing up the situation with respect to complex ores, it is evident that great progress has been made in ore dressing since the time when Freiberg methods were the world's models. There has been a development in machines and the method of their application, especially of the riffled top table, enabling the treatment of the finer material, and permitting finer crushing of the more intimately associated minerals. Progress had stopped at the point where slime began. The only development which could be called revolutionary followed, in the treatment of the fine material. Flotation took no account of relative specific gravities, and slime was no longer objectionable. A gap, however, remained. The separation of one heavy mineral from another by flotation has not in all cases been satisfactorily solved. The electrolytic process did not quite fill the gap, but made it narrower. Selective flotation has value, and it is to be hoped that it will be further developed. Volatilizing processes have also helped. Zinc oxide for pigment purposes was made on grates seventy years ago; blast furnaces followed and the reverberatory has extended the field. Zinc and zinc-lead oxide for pigments and other purposes are being produced directly from ore in America at the rate of 150,000 tons per annum—not much less in amount than basic white lead—and its use is growing much faster than that of the older pigment. If to this be added 100,000 tons of lithopone (20 per cent zinc), the combined tonnage will about equal that of white lead. Zinc chloride for timber preserving consumes a large quantity of zinc; most of it is now made from zinc galvanizers' drosses and hydrochloric acid. A beginning has been made in the manufacture of zinc chloride from the ore and salt, thus avoiding the hydrochloric acid plant.

The complex ores are found in many of the mining camps of the West and Southwest, and many demands exist for products which may be made directly therefrom without the necessity of conversion to zinc. This situation has extended the scope of the treatment problem materially.

Familiar Equipment in a Concentrator in Brazil



Frue vanners in lower mill of Ouro Preto Gold Mines, Passagem de Marianna, Minas Geraes

Pacific Coast Steel and Its Significance for Western Iron Mining

By Ellsworth Y. Dougherty
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DEPENDENCE, in a large part, upon remote sources for iron and steel supplies unquestionably has had a retarding influence upon the industrial expansion of the Pacific Coast. Much iron and steel machinery and many implements used in western industry have to be brought from the eastern half of the United States; hence, the industries of the coast are heavily penalized by being forced to pay high transportation costs above eastern factory prices. Western capital flows to eastern treasuries to pay for these products, profit goes to eastern interests, and many manufacturing payrolls and much industrial activity are lost to the Pacific Coast.

Present Steel Industry Restricted

Except for sundry foundry products and a restricted number of simpler forms manufactured in rolling mills, the Pacific Coast has been forced to draw upon foreign sources or upon the eastern United States for fabricated steel products that form the basis of construction and finished machinery and implement manufacture. The price has necessarily approximated eastern and foreign prices plus the cost of transportation to the Pacific Coast. Western iron and steel machinery and implement manufacturing has been retarded because high-priced iron and steel forms of remote origin have frequently made it unattractive to attempt to compete with eastern factories.

The fundamental reason for the restriction of Pacific Coast steel manufacturing has been dependence upon high-priced eastern and foreign pig iron. Just as in the case of steel forms not fabricated on the Pacific Coast, the price of pig iron has approximated the price of eastern or foreign pig plus the cost of transportation to the coast. Mills have grown up on the coast for making simple rolled forms from steel ingots produced in basic open-hearth furnaces charged with scrap iron and scrap steel, but extensions to these rolling mills involving large capital investment have been inhibited because it is considered that dependence on scrap alone is an insecure foundation. On the other hand Pacific Coast steel men have been rightly loath to make large investments in rolling mills depending upon high-priced pig iron of remote origin.

Need for Cheaper Pig Iron

Obviously, the great desideratum is a dependable cheaper supply of pig iron. Steel companies contemplating large plant extensions want control of their pig-iron supply, which implies control of the raw materials entering into its manufacture. The whole chain of circumstances is leading to the logical result, namely, the utilization of western iron-ore deposits in the manufacture of pig iron, to form a secure basis for steel manufacturing.

The stumbling block to pig-iron production in California or contiguous states has been the lack of coking coal. To supply California steel plants with pig iron there are three alternatives; if pig is produced in California, substitutes for coke must be used, or coke must be brought in from considerable distance; if the pig iron is manufactured elsewhere, it must be shipped to California.

The newly formed Columbia Steel Corporation proposes to show the way by adopting the last alternative. The essentials of its enterprise are shown in Fig. 1. Iron ore mined in the Iron Springs district of southwest Utah is to be shipped to a blast furnace near Provo, Utah. Coking coal, mined near Sunnyside, is to be shipped to a byproduct coking plant also near Provo. The coke and iron ore, with limestone obtainable near by, are the elements in the manufacture of pig iron at Provo, from which point the pig iron will be shipped to Pacific Coast cities and the western interior region. There will be established at Pittsburg, on San Francisco Bay, extensions to a plant now in operation there; these extensions contemplate the manufacture of wire, nails, rods and sheets, as well as castings, bars and billets now produced. To supply the mills with the necessary steel ingots, basic open-hearth furnaces will be charged with scrap and with Provo pig as needed.

Credit Due Columbia Steel Corporation

The Columbia Steel Corporation is to be congratulated on breaking the ground and showing the way for a new era for the western United States. The spokesmen of the corporation state that pig iron will be manufactured at Provo as cheaply as at Chicago or Pittsburgh, Pa. With a freight rate of $5.25 per long ton from Provo to the steel plant at Pittsburg, Calif., pig iron will cost $5.25 above the cost at Chicago or Pittsburgh, Pa. Steel products manufactured at Pittsburg, Calif., will not necessarily cost more than eastern steel by an amount equal to the transportation cost from Provo, because pig will be only one element in the cost of the finished steel. For instance, if the average charge of the future should be one-half pig and one-half scrap, and cost of scrap and operations of all description on the Pacific Coast about equal those of the East, finished steel forms at Pittsburg, Calif., will cost about $2.62 per ton above similar steel forms at eastern steel centers. This compares with about $10 per ton, upward to two or three times this figure, the usual range of additional cost to Pacific Coast consumers as compared with eastern consumers near the steel centers. This illustrates the tremendous importance to the west coast of expansion in steel manufacturing by such an enterprise as the Columbia Steel Corporation.

The Columbia project has all the essentials for success in the control of raw material and manufacturing from the fundamental mining operations to the finished product. There is a wide and expanding market for steel products in the western United States and a fertile field in developing export trade from Pacific Coast ports. There is also a large market for pig iron above the needs for steel manufacture. With this great expanding market ahead, it will be strange, indeed, if

western competition does not spring up and in this competition lies additional assurance of the continued advance of the west coast iron and steel industry. One or more competitive enterprises, proceeding along similar lines of a Utah blast-furnace plant, or upon the alternative line of Pacific Coast pig-iron manufacture, can confidently be expected.

The Columbia enterprize has the fundamental disadvantage of necessitating casting the molten pig at Provo, loading, shipping and unloading at the Pacific Coast plant, then remelting in the open-hearth furnaces. The great convenience and economy of charging molten pig direct from iron to steel furnaces in one centralized plant is thus lost. This suggests an alternative development in the Pacific Coast industry: the establishment of blast furnaces contiguous to steel plants at Pacific Coast seaports, especially in the San Francisco Bay district and the Los Angeles district. There exist in California large reserves of iron ore, notably in the Eagle Mountains, the Minarets, and near Heroult, in Shasta County, (see Fig. 1). There is no obvious reason why the ore from these deposits cannot be mined and shipped to the San Francisco Bay district or the Los Angeles district as cheaply as the Iron Springs ore can be mined and shipped to Provo. Moreover, Eagle Mountain ore and Heroult ore are known to be of Bessemer grades,[1] whereas analyses of the Iron Springs ore shows it to be non-Bessemer[2], so that the use of pig iron from Iron Springs ore is limited to the basic open-hearth furnace, in steel making, while Eagle Mountain and Heroult ore give a choice of Bessemer converting, if future economic conditions make this desirable.

California seaport blast furnaces will have to bring coke or coking coal long distances. Under certain conditions, however, the cost of transporting coke will offset the cost of pig-iron transportation. For instance, with equal ton-mile rates for pig iron and coke from Utah, the cost of coke transportation equals the cost of pig-iron transportation when one long ton of coke makes one long ton of pig. When the value of the byproducts at Pacific Coast industrial centers exceeds their value at or near the Utah coal mines, by an amount equal to the additional transportation cost of coal as compared with coke, per ton of pig iron, direct shipment of coking coal to the coast can be considered. In this event, a byproduct coking plant, blast furnace and steel plant can be operated with great advantage as one centralized plant.

Still another alternative in Pacific Coast pig-iron production is electric smelting. In a state so rich in hydro-electric power as California large continuous consumption near the source of power, thereby obviating expense in transmission and distribution, should result in comparatively cheap energy. When, in addition, iron-ore deposits are near the furnaces, thus obviating the expense of ore transportation, electric pig-iron production assumes great economic importance. The electric process permits consideration of substitutes for coke, such as charcoal and gas-carbon briquettes, both of which may be produced in California; and there is also the extremely vital point that only about one-third as much carbon is needed, as compared with the blast furnace, per ton of pig iron produced. Pioneer work has already been done at Heroult, Calif., in producing pig iron from iron ores. The location is extremely favorable for the purpose; ore and limestone can be delivered direct from deposit to furnace, without railroad transportation; and large hydro-electric projects are short distances away. The attitude of the power-producing companies in granting favorable rates is an all important element in the problem. Hydro-electric plants owned by pig-iron producing companies is an alternative to buying power. Except under inflated

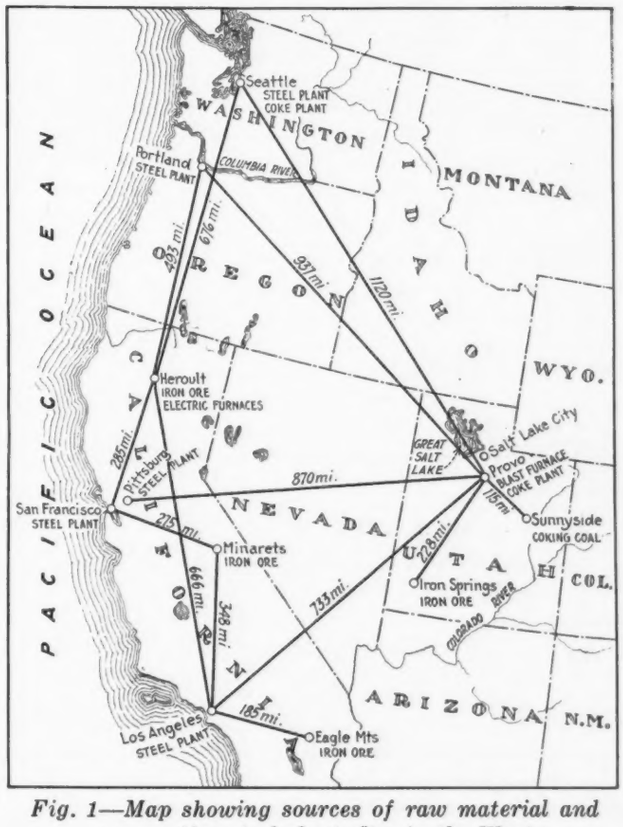


Fig. 1—Map showing sources of raw material and prospective steel-plant sites in the West

price conditions, the electric process for making pig iron in competition with the product of the coke blast furnace does not assume great attractiveness in California until power gets below about $16 per horsepower-year. Above this price the electric production of pig iron has a field in the production of a superior product such as electric charcoal pig; and, with growth on the coast of the iron and steel industry, the demand for such a superior product may give great impetus to the electric process. "Electric" steel made by passing molten electric pig iron direct from iron to steel furnace, or with the intermediate step of treatment in the open-hearth furnace or Bessemer converter, will produce a superior grade of steel, and the electric pig-iron furnace and steel furnace may, in this way, come to fill a very important rôle in the industry on the coast.

In order to bring out some possibilities in pig-iron production on the Pacific Coast the following figures are submitted for illustration. No claim is made for their accuracy. They merely represent reasonable expectations or assumptions that serve as a useful yardstick:

CASE 1. Iron ore from Iron Springs district, in southwest Utah; coking coal from Sunnyside, Utah, district; blast furnace and byproduct coking plant at Provo, Utah; steel

[1]U. S. Geological Survey Bulletin 503; "Iron Ore Deposits of the Eagle Mountains, Calif." By E. C. Harder. Analyses of Heroult ore on file at office of Noble Electric Steel Co., San Francisco, Calif.

[2]U. S. Geological Survey Bulletin 338; "The Iron Ores of the Iron Springs District, Southern Utah." By C. K. Leith and E. C. Harder.

furnaces at San Francisco Bay. This is the Columbia steel enterprise.

Cost per Long Ton Pig Iron

Iron ore mining	$3.00
Freight on iron ore from Iron Springs to Provo	3.50
Coke at furnaces, Provo	8.00
Limestone at furnaces, Provo	.50
Freight on pig iron to San Francisco Bay	5.25
Cost at San Francisco Bay steel furnaces	$20.25

CASE 2. Blast furnaces and steel plants in San Francisco Bay district or Los Angeles district; iron ore from the Eagle Mountains, the Minarets, or Shasta County; (a) coke from Utah; (b) coking coal from Utah.

Cost per Long Ton Pig Iron

	(a)	(b)
Iron ore mining	$3.00	$3.00
Freight on iron ore to San Francisco or Los Angeles	3.50	3.50
Coke at Utah plant	8.00	....
Coking coal at Utah shipping point	....	7.00
Freight on coke from Utah to San Francisco or Los Angeles	5.25	....
Freight on coking coal from Utah to San Francisco or Los Angeles	....	8.00
Limestone at San Francisco or Los Angeles	.75	.75
	$20.50	$22.25
Less value of byproducts above the cost of coking at San Francisco or Los Angeles	.....	1.75
Cost of pig iron at steel plants	$20.50	$20.50

CASE 3. Electric pig-iron furnace at Heroult, Calif.; Heroult iron ore and limestone; charcoal or gas-carbon briquettes from California or coke from Utah.

Cost per Long Ton Pig Iron

Iron ore mining	$3.00
Electricity @ 2c. per kw.-hr. ($13.07 per hp.-yr.)	5.00
Charcoal, gas carbon briquettes or coke @ $15.00 a short ton.	5.50
Electrodes @ 8c. per pound	1.50
Limestone	.25
Freight on pig iron at San Francisco Bay district	2.50
Cost at San Francisco	$17.75

General overhead expense and furnace operating costs will naturally vary with different organizations and processes.

With an increase in electric energy to 0.3c. per kilowatt-hour ($19.60 per horsepower-year) the cost of the electric process rises about $2.50 per long ton of pig iron. On the other hand a rise in the price of reducing and carburizing agent of $3 per ton reflects itself in a rise of slightly over $1 per ton of pig iron produced, whereas such a rise increases the blast furnace cost about $3 or more per ton of pig iron produced. The electric process permits contracting for hydro-electric power at a fixed rate over long periods of time, so that fluctuations in the price of reducing and carburizing agent is not proportionally the influential and unstablizing factor that such fluctuations are in the blast furnace process.

DEVELOPMENT OF THE INDUSTRY ASSURED

With the development of pig-iron manufacturing will come increased iron, coal and limestone mining, with increased tonnage for western railroads in transporting these raw materials. Pig-iron distribution will stimulate western freight movement, as will also the distribution of steel products and machinery. Coastwise ocean transportation should receive its share. Blast-furnace and electric-furnace operation with concomitant steel production will mean broadening industrial activity. In the fabricated products of steel mills will be found the basis of increasing western manufacture of agricultural, mining, lumbering, shipping, railroad, automobile, construction, electrical and other manufacturing machinery and implements. In a competitive market all users of iron and steel products should be benefited by lower cost and easier obtainment of these products as compared with present conditions. The sales branch or agency of eastern factories will be found in decreasing numbers, to be supplanted by the factory branch or the new western manufactory. This will come about because western iron and steel will be obtainable cheaper than the eastern product at Pacific Coast cities, hence the cost of iron and steel manufactured products will be less than that of the eastern product shipped in the West. With the growth of manufacturing in the West will come increased demand on steel mills, with consequent broadened and quickened activity back through furnaces to the mining of raw materials. Export trade will be sought and developed from Pacific Coast ports. All these developments can be confidently expected because the necessary supply of raw materials is available. A study of the economics of the problem shows their utilization to be feasible in competition with outside sources, and a rapidly expanding market of unusual promise is clearly ahead.

A Big Cave in New Mexico

Carlsbad Cavern Made a National Monument

CARLSBAD CAVERN is an immense cave in New Mexico that possesses unusual beauty and a great variety of natural features. It is in the eastern foothills of the Guadalupe Mountains, about 10 miles north of the Texas line and 22 miles southwest of Carlsbad, the principal town in southeastern New Mexico.

The cavern is said to have been discovered in 1901 by J. L. White and Bige Long, whose attention was drawn to it by the great numbers of bats they saw coming out of a hole in the side of a small valley. They entered the hole and found a cave containing large deposits of bat guano. These deposits were worked for several years.

Mr. White has recently explored several miles of the chambers of the cavern. About half a mile from the opening from which the bats were seen coming the cavern becomes phenomenally large and spectacular. About 3 miles of its hallways and chambers, including its most ornate parts, were surveyed last spring. The National Park Service recommended that the cavern should be made a national monument, and a proclamation setting it apart as recommended was issued by the President Oct. 25, 1923.

No part of the cavern has yet been thoroughly explored, but enough is known of it to show it will rank high among the famous caves of the world. Visitors familiar with other great caverns assert that some of its chambers surpass in size any others yet discovered. One room is more than half a mile long and several hundred feet wide, and its ceiling is so high that torchlights failed to illuminate it.

The floor of the cavern is 170 ft. below the entrance, which was formed by the fall of a small part of the roof. In a distance of less than 2 miles from this point the floor descends about 500 ft., yet the bottom of the cavern lies still deeper, for Mr. White has found chambers and hallways 200 ft. lower.

The geologic conditions in the vicinity of Carlsbad Cavern are unusual. The limestone in which the cavern has been carved is about 1,300 ft. thick and is underlain by an equally thick series of beds of soft red shale and sandstone that include thick beds of gypsum and rock salt. The occurrence of these easily soluble beds under the 1,300 ft. of hard, yet soluble, limestone may have produced a cavernous condition of the rock that will show spectacular results.

New concentrator of Betty O'Neal Mines Co.

Nevada's Newest Silver Producer —The Betty O'Neal Mine

By Walter S. Palmer
Acting Director, Mackay School of Mines, Reno, Nev.

IN NOVEMBER, 1922, the new mill of the Betty O'Neal Mines Co., in Nevada, was completed. Ten days later the first concentrates were shipped, and three months after that the company paid its first dividend, which was followed by a second in May, 1923.

The Betty O'Neal mine is in the Lewis district, in Nevada, near Lewis Canyon, on the west slope of the Shoshone Mountains, 12 miles southeast of Battle Mountain. It is about a half mile south of the old mining camp of Lewis, which at one time had a population of 1,000. The elevation of the mine is 5,350 ft. The Pittsburg district, in which are situated the old Dean mines and the Hilltop mine, adjoins the Lewis district on the east.

Deposit Discovered Fifty Years Ago

Silver deposits were first discovered in the district in the 70's, and from 1880 to 1882 the Betty O'Neal mine produced some high-grade ore. The total production of the district in the early operations is uncertain. At one time three mills were operating, but it is reported that under 30-oz. silver ore could not be profitably worked. In 1882 the mine was being sampled by L. W. Getchell, of Austin, Nev., father of the present manager, when the boiler of the surface plant exploded and killed two men. Resulting litigation caused the owner of the property, a Mr. Blossom, to suspend operations. A little work was done by leasers from then up until the death of Mr. Blossom in 1917. Mr. Getchell secured an option on the property in 1917 and attempted to pump out the workings which were then under water. The shaft was 336 ft. deep and there were lateral workings. The work was started with inadequate equipment and proved unsuccessful. While preparing for work on a larger scale he was taken sick and died in Battle Mountain. He had, however, told his son, Noble H. Getchell, about the results of his early investigations of the property and his belief that it was a very good one. The son therefore took up the work of reopening the mine, and, backed by George W. Sias, of Boston, secured a new option on it and organized the Betty O'Neal Mines Co. It cost $70,000 to unwater the workings and to do the necessary preliminary work to show evidence of a valuable property. The next step taken was to secure the immediately surrounding property. In 1922, the development work had opened sufficient ore to justify the erection of a small mill. Tests were made by the A. H. Jones Co., of Salt Lake City, which indicated that the ore could be treated by flotation at a recovery of better than 95 per cent of the silver values and a concentration ratio of 20 to 1. Cyanide tests on the ore made by the same company proved unsuccessful, owing to the high consumption of cyanide. It was therefore decided to erect a flotation mill of 150 tons' daily capacity. The mill was completed in November, 1922, and has proved successful. For a time the extraction reached an upper limit of 97 per cent and at present is 95 per cent. The mill is of special interest because of the method of treatment applied to a silver ore and the high recovery obtained.

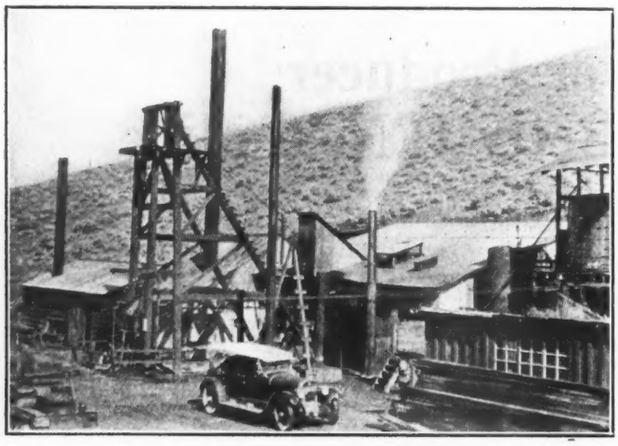
As already stated, the first shipment of concentrate was made ten days after the mill started, and three months later, as stated, the company paid its first dividend. A second unit was added to the mill in 1923, doubling the capacity. The company is at present confining its work to the Betty O'Neal and Estella claims, but it owns in all thirty-six claims and 480 acres of land adjoining the mineral ground. The claims held by the company extend its holdings to the old camp of Dean.

Property Gives Promise of Large Reserves

Two fairly well-defined veins have been discovered in the mine. One is known as the Betty O'Neal and the other as the Estella. The workings on these veins as yet are of insufficient extent to determine their relationship to each other. A close study of the orebody was not made, but the veins appear to be replacements in limestone, with subsequent fracturing and filling of the fractures with calcite, quartz, and the other vein

minerals. The veins strike almost north and south and dip west about 45 deg. on the average. The country rocks are limestone and slate cut by porphyry dikes. In places the limestone is highly silicified. The ore-bodies have been opened at various levels over a distance of 1,600 ft. on the dip, and on one level, known as the No. 4 tunnel, where the most extensive work has been done, the vein has been drifted on for 1,200 ft. and shows a width of from 12 to 55 ft. The north drift on this level ends in a stope in which the face is fully 35 ft. wide. This ore averages over 20 oz. silver per ton, and is the ore now being milled.

The lowest point where the ore has been exposed on the property is in the Getchell tunnel, where 20 ft. of ore averages 16 oz. per ton in silver. No drifting has been done on the vein at this point. The distance from this point to the highest point where ore is found in place on the property is over 1,600 ft. Ore is exposed in



Betty O'Neal mine surface plant

workings at several points along this slope. The mine gives promise of containing a large tonnage.

The ore is a mixture of silicified limestone and slate, fractured and cemented by calcite and quartz. It contains considerable graphite and some barite. The chief values are in silver, with some copper and lead and only traces of gold. Usually no return for gold in the concentrates is made by the smelter. The ore from the deeper workings shows a little more than a trace of gold, but not over $1 per ton in the richest ore. The chief silver mineral is freibergite, with accessory stephanite, argentite, and polybasite. Specimen ore assays as high as 4,000 oz. of silver per ton. The associated sulphide minerals are galena, tetrahedrite, pyrite, and sphalerite. In the oxidized ore near the surface the silver mineral is cerargyrite, associated with copper in the form of azurite and malachite. This combination of minerals in the oxidized ore makes it at present unsuited for either flotation or cyanidation and presents a problem for future experimentation.

The ore now being milled averages between 20 and 25 oz. of silver per ton. At one time sorting and direct shipment of the high-grade ore was tried, but did not prove advantageous. Selective mining could produce higher mill heads, but at present this is not necessary.

Mine Surface Plant Well Equipped

The mine surface plant consists of a small single-drum steam hoist of about 15 hp. built by Harron, Rickard & McCone. It is being operated by compressed air, although it was formerly supplied with steam power. Two Chicago Pneumatic simplate valve, single-stage air compressors, 9x14 in., 350 r.p.m., directly connected to semi-Diesel engines, furnish air at 90-lb. pressure for use by the mine drills, the small hoist, drill sharpener, and small power hammer. Compressed air is used for starting the engines. This air is furnished from a small air receiver, which receives its charge from an auxiliary gasoline-engine-driven air pump, 3x3½ in. in size.

The machine shop contains a Denver drill sharpener and a small power hammer made from a small air drill. At present all timber used is framed by hand. A small power saw is used for cutting wedges. The assay office handling the assays for both the mine and the mill is situated at the mine. It is equipped with the usual small pulverizers operated by a 2-hp. electric motor. The furnace is a small Braun portable run by gasoline. Heusser and Thompson balances are used.

The mine has been opened by a series of adits, seven in all, including the Getchell tunnel, and two shafts. One of the shafts is being used as a chute for ore from the No. 4 tunnel level to the 150 level of the main working shaft. The latter shaft has two compartments, one of which is used for a chute from the 150 level to the Getchell tunnel. The ore mined is coming from a 55-ft. stope above Tunnel No. 4 and Tunnel No. 5. Square-set timbering is used. The ore breaks well.

Two small machines, jackhammers and stopers, working two shifts, are keeping the mill supplied with 150 tons of ore per day. Hollow steel and wet machines are in use. Stoping is overhand, and numerous chutes result in cheap handling of the ore in the stopes. In several places in the mine the recent development work has shown that old mine workings ended within a few feet of high-grade ore and the large deposit now being worked. Filling in one old winze was drawn and run through the mill. It averaged 16 oz. per ton in silver. Such ore was evidently too low in grade to be worked by the earlier mills.

At times during the opening of the property large water pockets have been struck, which have proved troublesome. These were undoubtedly a factor in influencing the previous working of the property. The drainage of the mine by the Getchell tunnel has now removed this difficulty.

Carbide lamps are used underground. Lighting on the surface is by electricity. Ventilation in the mine is natural and is reported to be so good that three shifts can be worked without delays due to powder smoke. Both round and square timbers are used in the mine. The company management has found that it can advantageously utilize old railroad ties and has made a contract with the Southern Pacific to secure all of that company's old ties over a section of the railroad near Battle Mountain. Old ties cost 25c. apiece delivered at the mine.

The Getchell tunnel was run for drainage and to provide a suitable haulage adit through which the ore could be easily transported to the mill. The mill is about 150 ft. from the portal of the tunnel. The mine is making about 100 gal. of water per minute. This is run into a small reservoir near the portal, from which it is pumped to the mill storage tank of 30,000 gal. capacity. Water for domestic purposes comes from springs in a near-by canyon adjoining that in which the mine is situated.

The broken ore is drawn from the stopes through chutes into mine cars and trammed a variable distance

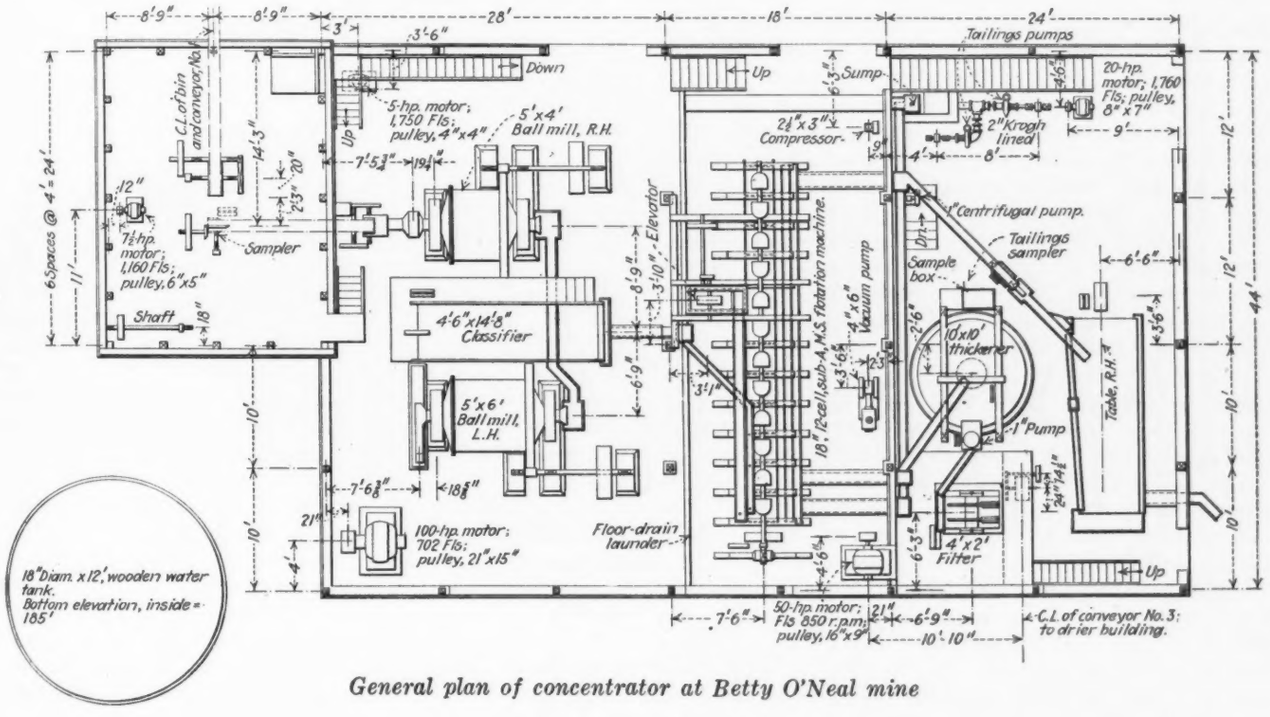
to the portal of No. 4 tunnel, near which an old shaft has been converted into an ore chute connecting with the 150 level from the main working shaft. This chute is about 350 ft. deep from the tunnel level to the 150 level. On the 150 level the ore is trammed a distance of about 225 ft. to a chute in the main working shaft, down which the ore is passed to the Getchell tunnel, a distance of 180 ft. From this point the ore is hauled to the mill a distance of 2,200 ft. by a train of twelve Matteson, improved 1.25-ton side-dump cars, and a Mancha storage-battery locomotive. The track is laid with 35-lb. rails. It is planned to eliminate the tramming on the intermediate level as soon as possible and to pass the ore directly from the upper tunnel to the Getchell tunnel. One set of storage batteries is held in reserve while one set is in use. Charging is done by a Chandeysson charging set, consisting of a 5-hp. induction motor direct-connected to a 3-kw. generator, rated at 55 amp. and 55 volts. A chain block and overhead crawl for handling the storage batteries from the locomotive to the charging platforms is used.

The Getchell tunnel has a 6x7 ft. cross-section. The total length of this tunnel is 2,600 ft. The company plans to gradually extend this tunnel as a prospect tunnel. It has purchased the claims lying to the east of the Betty O'Neal claim. The claims contain veins which were worked near the surface and which strike about north and south and dip westerly. The Getchell tunnel will crosscut these claims. It was constructed at a cost of $10.63 per foot.

The mill buildings are of wooden frame construction covered with boards and corrugated iron on both the sides and top. The floors are cement throughout the mill, and all drain to a common sump. The machine shop at the mill is equipped with a 12-ft. South Bend lathe, hot-flame welding outfit, pipe-threading machine, drill press, shaper, power saw, and emery wheels, with which equipment it takes care of ordinary machine repairs around the mill. Fire protection is afforded by several lines of hose conveniently placed in the mill, as well as a number of Pyrene and Alert fire extinguishers of the acid-soda type distributed at different points in the mill buildings. The total cost of the first unit was $110,000 and the cost of the second unit was $90,000.

The mine ore train is weighed on Fairbanks platform scales and the cars are dumped into a small 50-ton, flat-bottomed receiving bin. At the bottom and center of the bin is placed a No. 4 Allis-Chalmers gyratory. Flood feeding is therefore made use of, and appears to be satisfactory. A Yale triplex block supported by a crab and I-beam over the bin and crusher handles the crusher parts in making renewals.

The ore, crushed to 1-in. size, is fed to a 125-ft. belt conveyor, 12 in. wide, which delivers it to the top of the mill bin. Plans are under consideration to remove the coarse crusher to the mine. The crusher is driven by a 25-hp. Fairbanks-Morse, Type-B induction motor. All coarse crushing is done on the day shift. As the ore is discharged at the end of the conveyor into the mill bin, the ore stream is cut by an automatic sampler, which takes a sample every fifty-five seconds and discharges into a small box at the side of the conveyor, from which the sample is removed. A 7.5-hp. induction motor operates the conveyor and sampler. The mill bin is of wooden construction with a flat bottom. Under the bin are two Hamill belt-type feeders for delivering the ore to each of the two units of the mill. In the new unit the feeder discharges the ore upon a 25-ft. belt conveyor leading to the ball mill.



General plan of concentrator at Betty O'Neal mine

Main Features of Mill Arranged in Two Units

The second unit was built in 1923, and, although the general scheme of treatment is the same in both units, changes have been made in the detailed arrangement and machine sizes used in the unit last constructed. In No. 1 unit the grinding is done in two Joshua Hendy ball mills; the first is 5x4 ft. in size, using 5-in. chrome-steel balls, and the second is 5x6 ft., using 3-in. balls. The second mill is operated in closed circuit with a

Dorr duplex classifier. Smooth manganese-steel lining is used in all of the ball mills. Crushing has been to minus 65 mesh, but recent tests indicate that as coarse as 45 mesh will give equally good results. At present the adoption of coarser crushing is being considered. The ball mills and classifier in No. 1 unit are driven by a single 125-hp. induction motor through belts and line shafting with clutches on each mill. In No. 2 unit each mill is driven by an independent motor with chain drive. For the coarser grinding a 5x4-ft. mill is used, driven by a 50-hp. induction motor, and for the fine grinding a 5x8-ft. tube mill, driven by 100-hp. induction motor. The change to a longer mill has been found to give better results. The ball mills are operated at a speed of twenty-four revolutions per minute.

Classifier Overflow Floated

The overflow from the classifiers is fed to two Minerals Separation subaëration machines. In No. 1 unit an 18-in. twelve-cell machine is used; in No. 2 unit an 18-in. fourteen-cell machine has been installed. The agitators in the cells are operated at 380 r.p.m. Three cells in each machine are used as cleaners, the remaining cells being used for roughing. A Callow machine has been installed and will be tried out in further cleaning of the concentrate. After passing the flotation cells a portion of the tailing is cut out of the stream and passed over a Wilfley table, which acts as a pilot to control the operation of the flotation cells. A full-sized table is used in unit No. 1 and is placed on a lower floor. It is planned to duplicate the arrangement in No. 2 unit, but a smaller table will be used, and it will be placed on the same floor and near the flotation cells, so as to facilitate operations and to have the pilot table constantly under the eye of the flotation operator.

The ratio of concentration is 20 to 1 and extraction is maintained at 95 per cent of the silver values. The concentrates contain, in addition to the silver, about 1.5 per cent of copper and 5 per cent of lead.

The flotation reagent which was used up to recently was a mixture of solvent naphtha, manufactured by the Barrett Co., and pitch, added by a pulley type of feeder to the feed to the ball mills. Later, pine oil and Barrett No. 4 oil are added as required from pans placed on top of the flotation machines, with drip cocks introducing the oil directly into the flotation cells. With these reagents an extraction of 97 per cent was secured. The company has not been able recently to obtain the solvent naphtha and has substituted gasoline to cut the pitch. The pitch is first melted and then mixed with gasoline in a ratio of 3 lb. of pitch to a gallon of gasoline. This gives a fairly fluid mixture. The extraction fell off 2 per cent with the gasoline substitute.

The concentrate is run into a 10x10-ft. Dorr thickener. For a time hot water from the engines in the power house was added to aid settlement, but this practice has now been discontinued, and it is anticipated that more thickening area may be required when running both units to capacity. The concentrate is drawn from the thickener by two Dorr diaphragm pumps and sent to a two-leaf American filter. The filter makes a ½-in. cake averaging about 13 per cent moisture. The concentrate is discharged to a belt conveyor running to the top of a drying oven and dried to 6 per cent moisture and then sacked for shipment to Utah smelters. Fuel for drying amounts to 500 lb. of coal per twenty-four hours. Coal costs $17 per ton at the mine. A 20-hp. motor operating through line shafting runs the Wilfley table, thickener, filter, pumps, and conveyor for delivering concentrate to the drier.

Although both units have not been operated to capacity, the expectation is that the ore can be treated in the mill for a cost not to exceed $1.80 per ton. The total cost of mining and milling, including all expenses, will not exceed $4 per ton. All tailings from the mill are caught in a pond below the mill on ground owned by the company. No attempt has been made to save and reuse the mill water, except that which comes off from the concentrate thickener.

Electric power for the mine and mill is generated by two 300-hp., six-cylinder, Type Y, Fairbanks-Morse semi-Diesel engines directly connected to two 200-kw., Type D, Fairbanks-Morse alternators, supplying current at 460 volts, 60 cycles. Alternating current at this voltage is used in the various motors throughout the plant. For lighting, the voltage is reduced by transformers. The oil used for fuel is a distillate of 27 deg. Bé. It costs 5.25c. per gallon in Battle Mountain and $5 per ton for transportation to the mine. The oil is hauled in two auto tank trucks and placed in a 10,000-gal. receiving tank at the mine. Each engine requires about 17 gal. of oil per hour. Power costs $6 per horsepower-month. Hydro-electric power was offered from Lahonton, Nev., to the company by the Nevada Valleys Power Co. for $10 per horsepower-month.

For cooling the engines in the power plant mine water was used direct from the mine and then later used in the mill to aid settlement. It was found, however, that a deposit formed in the jackets, which resulted in cracking the cylinder heads of the engines. A plan was then adopted of treating the water with chemicals and cooling it after use in a cooling tower before returning it in the engines. This method has proved successful. The cooling tower is 10x18x12 ft. high, with eight 18-in. shelves in five rows, the water being fed from troughs at the top of each row, flowing down over the shelves to a rectangular tank below.

An auto stage for passengers, mail, and express is operated between the camp and Battle Mountain. The fare for the round trip is $5. Transportation of supplies is by auto trucks under a contract with the company at $5 per ton for outgoing freight and $3 per ton for back haul. There are three fair dirt roads leading to the mine, but in wet weather parts of the road are soft and at times almost impassable. At one time a narrow-gage railroad extended to Lewis, but this road was removed soon after the early days of the camp. A franchise for a new railroad was granted to the company by the last state Legislature, but as yet construction work has not been started. It will require a road about 6 miles long to connect with the nearest point on the Nevada Central R.R. a narrow-gage railroad between Battle Mountain and Austin.

Living conditions at the camp are good. The company has built fifteen two- and three-room houses, with baths, for the married men, a house for the manager, and five bunk houses, each capable of housing fourteen men, for the unmarried men. The boarding house is capable of accommodating eighty-five men at one time. A recreation hall has recently been erected.

The mine is in charge of Noble H. Getchell, vice-president and general manager. Tom Peadon is mine superintendent, and R. J. Spry, mill superintendent. I am indebted to these men for their courtesies in showing me through the property and supplying me with data contained in this article.

DISCUSSION

"Engineering and Mining Journal-Press" is not responsible for statements or opinions published under "Discussion." In many cases the views expressed are diametrically opposed to editorial policy and belief.

Leakage at Teapot Dome

THE EDITOR:

Sir—Your editorial on "Leakage at Teapot Dome," while doubtless well intentioned, leaves an implication as to difference of opinion between the U. S. Geological Survey and the Bureau of Mines that is not warranted. Both bureaus are on record as believing that at least some land in Naval Reserve No. 3 would eventually be drained by wells outside its boundary. Both recommended leasing within the reserve. The Geological Survey, with one set of facts before it and interpreting those facts, specified particular definitely limited small areas to be leased in a specified order and recommended against other leasing; an entirely proper recommendation for the Survey to make. The Bureau of Mines, with the same and other facts available, and taking into account additional matters, recommended a larger lease, a recommendation I conceive to be equally proper in view of the conditions. I fail to see anything "lamentable" about such a difference.

It is not unusual for geologists alone, to say nothing of geologists and engineers, to differ as to policy and methods in development of an orebody. Why should they not differ as to development of an oil field? The Bureau and the Survey have somewhat different points of view and different responsibilities. Each must make its recommendation to the Secretary when called upon to do so, with entire fidelity to its own best judgment, and the fact that such judgments do not always exactly coincide is not, fortunately, a matter which disturbs friendly relations within the department. I am at a loss to understand why such difference as has arisen in this case "discredits petroleum engineers and the government bureaus." The implication that it does is one of the best means of bringing it about.

Washington, D. C. H. FOSTER BAIN,
Director, Bureau of Mines.

Oklahoma's School of Mines

THE EDITOR:

Sir—Permit me to correct a slight error in the issue of Jan. 19 in which there is a statement regarding the presidency of the Oklahoma School of Mines. This change was made in July, 1923. You have received correspondence from this institution, but an examination of your files should show that Mr. Johnson's signature is lacking. The spelling of the town "Wilberton" should be corrected to "Wilburton."

I am very sorry this error has been made as we are but a small school and would like whatever notice we can secure to be correct. Due to certain political activities of the state, it has been difficult to bring up our attendance. To those few who are or were familiar with our school, your notice did not convey the fact that a complete change of faculty has raised our status from our former one of a mere trade school. We are making an effort to build up a mining school. The present faculty are engineers of degree and experience and the entire policy of the school has changed. Over 100 coal miners of the state are enrolled in our correspondence courses, fitting them for the state mining examinations for pit boss, fire boss and superintendent. These courses were written and edited by professors of the school and have been very successful, taking the practical coal miner of limited education from the multiplication tables up through decimals, square root and ventilation problems, including as well the study of gases, and a training in testing, the use of lamps, and in laws, duties and safety measures.

In extension work there are enrolled at Henryetta, Okla., seventy-six men of similar education, who go to school two hours each night, five nights a week. A new night school is now established at McAlester, and at Poteau, Okla., we have promise of a nightly attendance of over fifty miners, which will result in the establishment of a school there as well.

In residence, we are maintaining about fifty students, most of whom are vocational men, under the care of the Veterans' Bureau, who are taking short courses in trades subjects. However, we are teaching this term the following subjects: assaying, metallurgy, electricity, thermodynamics, general, structural and economic geology, calculus, English and ore dressing. Two men will graduate this spring in mining engineering.

If you will compare this work with the effort of the past you will understand why the inference that no change has been made is not merited.

Wilburton, Okla. JOHN K. WALSH,
President.

Ore-bearing Parallelisms

THE EDITOR:

Sir—In the writer's experience he has observed, in a number of cases, while following ore deposits in veins, that if the dip or strike courses of the veins should make any considerable change, the ore would become leaner and, in some cases, cease to carry values altogether.

Then if the vein were followed on its strike or dip courses until it would again resume the ore-bearing parallelism, that parallelism would carry ore.

If this were found to be a general rule in ore-bearing veins, it would tend to establish the formula that

There are certain parallelisms in the dip- and strike-courses of veins that carry ore, while the alternating parallelisms do not.

It would be interesting from a scientific and practical standpoint if the readers of the *Journal-Press* would contribute their personal observations as to this.

Parral, Mexico. B. MACD.

THE MINING NEWS

The Mining News of ENGINEERING AND MINING JOURNAL-PRESS is obtained exclusively from its own staff and correspondents, both in the United States and in foreign fields. If, under exceptional conditions, material emanating from other sources is published, due acknowledgment and credit will be accorded.

Summary of the Week

SUSPENSION of production by the Anaconda Copper company at its Berkeley and Pennsylvania mines at Butte, following curtailment by the Calumet & Hecla and Inspiration companies, marks a start toward the reduction of copper output aimed to bolster up the price obtained for the metal.

A new company has been formed to adapt the Salida (Colo.) smelter for the treatment of complex zinc ores by the Gordon process, which uses gas-house liquor.

Work is under way on the Diamond Creek power project on the Colorado River. The Girand interests, supposed to be connected with copper mining, seek to protect their rights.

According to tax returns, the Utah Copper Co. netted $8,571,415 from $30,003,994 gross income during 1923.

Monthly shipments of rich lead ore from the Ahumada and Erupcion mines, south of El Paso, total 12,000 tons.

Operation of the Nickel Plate mill in British Columbia has been resumed by the Hedley Gold Mining Co.

Tariff specialists in Washington for the most part agree that free copper is best for the interests of the general public.

Lake Superior copper producers are solidly behind the proposal to urge a tariff on copper imports.

Collapse of the rebellion in Mexico has renewed activity in development in several mining districts.

Iron mining in Minnesota is unusually active for this season of the year. New equipment is a feature.

Increase in electric power rates in Colorado will augment the burden of the mining industry.

Shareholders in the Candelaria Mines Co. fail to respond to the reorganization plan, and the property will probably be sold to the Rochester Mines Co.

Minnesota Iron Mining Unusually Active for Off Season

Underground Output High—Stripping Operations Under Way—Much New Equipment Ordered

Activity on the iron-ore ranges in Minnesota is becoming steadily greater. The underground mines on all of the ranges have been working at capacity, which will materially increase the tonnage loaded during the coming season from stockpiles. In almost all instances where stripping projects were discontinued due to weather conditions or for repairs, resumption is under way or will be in the immediate future. Many large orders for equipment have been placed for open-pit mining. Some of this equipment takes care of replacements, but in most cases it is additional, in anticipation of increased requirements. The largest order has been placed by the Oliver Iron Mining Co. for distribution on the Mesabi range. This order includes two 40-ton locomotive cranes; three 50-ton caterpillar-mounted revolving steam shovels; one 100-ton caterpillar-mounted revolving steam shovel; one 50-ton all steel, air-operated spreader plow; twenty-seven caterpillar mountings for standard railroad type 100-ton steam shovels; twenty-five 30-yd. stripping cars; seven flat cars with steel underframe of 100,000-lb. capacity.

New Pipe Line in Argonaut Shaft Affords Fire Protection

A 5-in. pipe line is being installed in the Argonaut shaft at Jackson, Calif., where 47 men lost their lives in the summer of 1922 as the result of a fire which could not be controlled. The line will extend from the surface to the lowest level. It will be used as a column pipe and also for fire protection. Valves are being placed at 100-ft. intervals in the shaft and connections are being made at the surface to supply the pipe line with water in emergencies.

A second order has been placed by the Pickands-Mather Co. for stripping and ore operations at its properties on the Mesabi Range. This order includes one Marion Model No. 350 electric shovel with General Electric direct current operation; one Bucyrus Model 80-B with Westinghouse equipment using alternating current; one 45-ton Industrial crane; six American, six-wheel switching engines, and one Lima switching engine. Other substantial orders have been placed by the operators, and the Northern Pacific R.R. has ordered 200 ore cars of 75-ton capacity from the Pressed Steel Car Co. for use on the Cuyuna Range.

Baxter Springs Race Track Now Good Zinc Mine

Federal Drilling in Kansas Section of Tri-State Zinc District—Oklahoma Woodchuck Rebuilds Mill

Successful operations are being conducted by the Race Track Mining Co., which recently opened, built a mill, and started producing on a track a short distance west of Baxter Springs, Kan. Bernard E. Brown, of Joplin, is manager, and one of the principal owners.

F. W. Evans, owner of the Empire Development and Southern mines, in the Kansas section of the field, has obtained a lease on the Crescent lease, also in the Kansas section, and plans to install machinery in the mill building that stands on the lease, and place it in operation. He has put down several drill holes with encouraging results.

The Federal Mining & Smelting Co. is operating sixteen drill rigs on the properties of the Childress-Moses interests, upon which it recently obtained a working option.

The Oklahoma Woodchuck Lead & Zinc Co. has completed the framework on the new mill it is building west of the site of the old mill, which was destroyed by fire on Jan. 5, just south of Tar River, Okla. Machinery is being installed and with favorable weather conditions the property should be producing again soon.

Utah Copper's 1923 Output Largest Since 1918

Net Proceeds $8,571,415 from Mining 11,938,346 Tons of Ore—Gross Value $30,003,994

During 1923, the Utah Copper Co. had the heaviest production since 1918. There was produced 196,528,802 lb. copper, an increase of 108,495,449 lb. over that of 1922. The heaviest production by the company was in 1917, when the output was 204,855,118 lb. During the year just ended the Utah Copper milled and concentrated 11,167,800 tons of ore, of an average grade of 1¼ per cent copper. In the last three months of the period there were produced and milled 3,426,000 tons, or at the annual rate of 13,705,600 tons, which may be compared with the total output of the banner year of 1917, which was 12,545,000 tons.

The combined productive capacity of the Arthur and Magna mills, according to the last quarterly report, is 40,000 tons daily, or at the rate of 15,000,000 tons a year. According to figures just presented to the Utah State Board of Equalization, on which taxes are based, the company mined 11,938,346 tons of ore in 1923. This compares with 4,238,251 tons of ore produced in 1922. The metalliferous content of the ore mined compared in the two years as shown in the following table:

	1923	1922
Gold, oz.	72,635	28,314
Silver, oz.	636,422	258,301
Lead, lb.	248,965	62,481
Copper, lb.	195,142,919	84,778,655

From the sale of ore the gross yield was last year, according to the report, $30,003,994.96; in 1922 it was $12,342,521.97. Deductible costs for the two years compare as follows:

Extraction Costs	1923	1922
Mining	$2,286,627.58	$1,126,243.39
Development	1,132,115.32	379,505.42
State and local taxes	411,486.16	237,041.34
Totals	$3,830,229.36	$1,779,022.09
Reduction Costs		
Milling	$6,453,703.53	$3,796,819.80
Smelting	6,505,359.31	2,424,471.22
Totals	$12,959,062.84	$6,221,291.02
Transportation	$1,199,187.84	$631,521.53
Construction	3,444,099.75	867,533.04
Total deduction	$21,432,579.79	$9,499,367.38

This left net proceeds of $8,571,415.17 to be reported for 1924 valuation, as compared with $2,843,154.59 for 1923.

West End Ships Two Cars from Mabel Mine

The West End company shipped one car of gold-silver-lead ore from its Mabel mine near Mina, Nev., in February, the average value being $132 per ton. Another car was shipped on March 7, from which returns have not as yet been received, but it is believed that it will run as good or better. Development is being pushed on the 400 level, to determine the extent of the oreshoot at this elevation. Principal stoping is being done above the 300 level. Much native silver and some free gold have been found; this is rare for the district.

February Copper Shipments Largest in History

SHIPMENTS of refined copper by American producers were 234,000,000 lb. during February, according to figures current in the trade. This is a new high record, comparing with 224,000,000 lb. last November, the previous high month. Shipments for the last four months total 864,000,000 lb., an average rate of 216,000,000 lb., the highest four-month average in the history of the industry. Of this, 130,000,000 lb. represented average of domestic shipments and 86,000,000 foreign.

Stocks of refined copper in the hands of American producers are 291,000,000 lb. as of March 1, compared with 311,000,000 Jan. 1 and 253,000,000 Oct. 1, 1923, when the last increase in refined stocks began. Refined copper output in February was 205,000,000 lb., a decrease of 25,000,000 lb. as compared with January. Foreign shipments were 92,000,000 lb. for February, against 70,000,000 in January and 86,000,000 in December.

Will Diamond Drill Copper Mountain Property in Alaska

The Kennecott Copper Co. has abandoned its option on the Copper Mountain property in the Kantishna district, in Alaska. Development work had only been started when the company quit. There are large surface exposures of low-grade copper, lead, and zinc sulphides, which may or may not be of sufficient size and grade to make a big mine. Tom Aitken, veteran dredge operator of Alaska, who holds the original option on the ground, now plans to diamond drill the orebody next summer. The property is 60 miles from the Government Railway and if it develops into a mine it must be on a scale that will warrant building a branch railroad into the Kantishna.

Lake Superior Copper Producers Solidly Behind Tariff Proposal

If action is taken at this session of Congress in behalf of a tariff on copper, the initiative may come from the Michigan district. High-cost producers are the hardest hit by depression in the metal market, and Michigan is in this class. Lake Superior mining men now are united in the belief that a tariff offers the only permanent solution of the situation and is the one thing needed to stabilize the market. It is pointed out that production in Michigan is on a basis of only 55 to 60 per cent of normal and that Calumet & Hecla, with its rich Ahmeek mine, conglomerate copper rock, and copper sands, cannot earn dividend requirements. Other companies are in similar condition. A tariff levy of 5c. per pound likely will be asked. The point is stressed that American producers are compelled to mine only high-grade ore and continuation of this policy means ground of low-grade copper content probably will be forever lost.

Colorado Power Co. Raises Power Rates; Burden to Mines

Federal Court Overrules State Utilities Commission—Later Refused Increase—Case to Be Appealed

Notice has been served by the Colorada Power Co., which serves several of the principal mining districts in Colorado, that on March 1 the new rates will go into effect, which in some instances double the present charge. The Colorado Utilities Commission and the Colorado Metal Mining Association will appeal the decision of the Federal Court to the United States Supreme Court, and the increased rates will be paid under protest.

Early in 1921 the Colorado Power Co. made application to the State Public Utilities Commission for permission to increase rates from 25 per cent to 40 per cent. The petition for increase was resisted by several mining companies at the hearings held before the commission at various dates. In June, 1922, the Utilities Commission rendered a decision denying the application of the power company.

On Jan. 10, 1923, the Colorado Power Co. filed suit in the Federal Court against the members of the Colorado Public Utilities Commission protesting against its decision, and asking for a restraining order which would permit the desired increase in rates to at once go into effect. The Colorado Power Co. contended that "the present rates are unfair, unreasonable, and confiscatory," and that federal statutes in regard to property rights override the Colorado laws in respect to the powers of the Colorado Utilities Commission. The Colorado statutes provide that the decisions of the Utilities Commission may be appealed to the Supreme Court, but the power company declined to seek this method of relief, and the question now appears to hinge on the rulings of a federal court respecting the powers of the Colorado Utilities Commission.

On Jan. 4, 1924, a decision was rendered in the Federal Court permitting the company to increase its rates under certain schedules, particularly those applying to the service furnished to the mining districts.

Allen Hopes to Re-finance Boston & Montana Operations

W. R. Allen, president of the Boston & Montana company, operating at Wise River, Mont., accompanied by Franklin King and C. Coggan, Boston attorneys, who have charge of the legal matters in connection with the readjustment of the company's affairs, has been in Butte.

Mr. Allen said that the Boston end of the corporation business and finances had already been adjusted to the satisfaction of the stockholders. He expected to start at once on the Montana end of the business, and hoped that the company would again have the Boston & Montana property in full operation.

The property has been in the hands of the district court of Beaver-Head County for about a year. For several months a few men have been employed on repair work in the mine.

Candelaria Shareholders Evince Little Interest in Reorganization

Rochester, Largest Creditor, Probably Will Foreclose—Assessment Plan Fails—Curtain About to Drop

The special meeting of the stockholders of the Candelaria Mines Co., called in January, was so poorly attended that there was not sufficient representation to consider the proposed reorganization plan. The plan, as roughly outlined in November, 1923, was to make the stock assessable, pay the debt of the Rochester Silver Corporation, which amounts to over $400,000, by assessments, and then to resume work at the mine in an attempt to develop sufficient ore to resume milling operations, paying for this work by further assessments on stockholders.

Apparently the stockholders do not favor the plan, but prefer to let the Rochester Silver Corporation foreclose on the property and proceed with development at its own expense. In order to clear up this indebtedness, present stockholders in the Candelaria company would have to pay about 14c. per share in assessments, with the unalluring prospect of paying 5 to 10c. per share additional in order to put the plant in operation and finance development work in the mine, with a slim chance that ore would be found to reimburse them in the way of dividends.

The Candelaria company started its 400-ton milling plant at Candelaria, Nev., in 1922, and engineers' estimates indicated sufficient ore, mostly in fills and dumps, for several years' operations at a profit. The drop in the price of silver, after completion of Pittman Act purchases, coming six months sooner than anticipated by company officials, combined with the lamentable fact that the tonnage and grade of probable ore were both materially reduced when actual mining was started, resulted in unprofitable operation after June, 1923, and the company was forced to close down on Nov. 15, 1923.

Open Old Virginian Mine Near Kingston, N. M.

Operations are expected to start within a short time on the Virginian mine, 9 miles north of Kingston,, N. M., owned by John H. Moffett. The mine is being shaped up and the machinery overhauled for restarting at an early date. The property has a record of some phenomenal silver ores produced during the 80's. There is a mill and compressor plant and the ground has been opened by a 400-ft. tunnel, which will be extended in the hope of opening other shoots.

Duthie Mines Shipments Total 1,000 Tons

Since the Federal Mining & Smelting Co. took over the management of Duthie Mines, last summer, it has shipped close to 1,000 tons of high-grade ore to the Selby smelter, practically all of which has come from the Henderson mine. The company also is developing the Mamie mine, in the same group. The properties are situated in British Columbia.

New Railroad in Nevada Helps Mining Situation

THE completion of the Rogerson-Wells branch of the Union Pacific into Nevada during the current year is indicated by local reports, which state that efforts are being made to complete the railroad from Rogerson to Contact, Nev., by Oct. 1, 1924. It is rumored that a branch line to Jarbidge, Nev., is under consideration. In the meantime mining activity at Contact has increased. A new mill is being constructed by the Bluster Consolidated Mining Co. at Jarbidge.

Danielsville, Montana Ghost Camp, Stirs

The recent sale of two mining claims in the old Danielsville district 35 miles west of Butte, Mont., promises activity there during the coming summer. The Danielsville district is one of the early Montana camps, and at one time was a good producer. Very little mining has been done there in recent years.

Erupcion and Ahumada, Shipping 12,000 Tons Monthly, Pay Dividends

At a meeting held in El Paso, Tex., on March 3 the Erupcion Mining Co. and the Ahumada Lead Co. declared regular dividends of 7½c. and an extra dividend of 7½c. per share, both dividends being payable April 2 to stock of record March 15. The Erupcion declared three dividends of 12½c. during 1923 and the Ahumada declared one dividend of 10c. for the last half of 1923. The two companies are reported to be shipping from 10,000 to 12,000 tons of lead ores to the El Paso smelter each month.

Last week an unfortunate accident occurred at the Erupcion mine, a gasoline tank having exploded, which will interfere with mine operations for possibly a month. The decrease in output will amount to about 1,200 tons of pig lead. The directors have been re-elected.

Rich Silver Strike in El Salto Mine, in Western Chihuahua

According to a telegram received March 3 by interested parties in El Paso, a new strike has been made in the El Salto mine, in the Urique mining district, in western Chihuahua. The property is being worked under lease from the Becerra estate by Eduardo Enriques, mining engineer and brother of the Governor of Chihuahua. In driving a crosscut the bonanza was struck. The ore is reported to assay as high as 5,000 oz. silver per ton. The vein struck is the extension of the vein worked in the old Rosario mine that made the Urique camp famous and which made the family of Buena Ventura Becerra, who worked it for many years, very wealthy.

High Lead Market Causes Stir in Cooks Peak District

Promoters of Romaho Company Have New Project in New Mexico—Mill Planned for Graphic Mine

The present high price of lead has caused a shadow of mining activity in the old Cooks Peak district, northeast of Deming, N. M. A ten-year lease has been secured upon the Desdemona, Othello, and Monte Cristo mines, belonging to the El Paso smelter, by Major General Robert L. Howze and his associate, Peter Mack. These old properties were large lead producers at one time, but have been dormant for many years. A five-year lease and bond has been taken by the same parties on the Summit group of six claims and the Inez and King Solomon groups in the same district. It is the reported intention to develop the property. Messrs. Howze and Mack were the promoters of the Romaho Mining Co. in 1920, that was organized for a million shares of $1 par. The claims of the company are in the Tres Hermanas Mountains south of Deming. The stock was listed on the New York Curb, but did not get far. It is understood that efforts have been made recently to have the incorporation of the company canceled.

The old Graphic mine, south of Cooks Peak, that was purchased about two years ago by Samuel L. Houghton, formerly geologist for the Chino Copper Co., and associates, has come up to expectations, and extensive orebodies of good grade have been opened on the lower levels. A 50-ton mill has been provided and will be in operation within a short time.

Copper Range Opens Good "Rock" in Tri-mountain No. 2

At the Copper Range Consolidated, in the Michigan copper district, mining operations still are confined to the Champion and Baltic shafts. Development work continues in Tri-mountain No. 2 shaft, where the good showing, noted more than a year ago, persists. Some splendid ground is being opened up, which will be available for stoping when metal market conditions warrant a larger output. During the last three months there has been a net gain in number of underground men employed at the Copper Range mines, and the labor situation is quite satisfactory under prevailing market conditions. Copper Range production is in excess of 2,100,000 lb., refined, per month.

Sodium Sulphate Mine, in Arizona, Ready for Production

Owners of the sodium sulphate mine, at Camp Verde, Ariz., are making ready to begin production. The mill for treating the material is nearing completion and power connections have been completed. It is expected that about forty men will be employed at the property. The material will be quarried, washed, and treated in a drier, and then shipped to Clarkdale by truck for shipment to consumers on the Pacific Coast.

Anaconda Shuts Down Pennsylvania and Berkeley Mines

Production of ore at two of the largest mines of the Anaconda Copper Mining Co. in the Butte district—the Pennsylvania and the Berkeley—has been suspended. Suspension is explained by the fact that operations there at the present price of copper were showing a loss. The value of the ore in these mines is less than that at other properties of the company in Butte and the cost of mining greater. Continuance of operations would have meant the exhaustion of orebodies at a loss, it is said.

Telluride Mill, at Oatman, Make Excellent Extraction, Is Report

The Telluride mill, at Oatman, Ariz., now is treating 50 tons per day, and a recovery of approximately 97 per cent is being made. Few adjustments have been required since the starting of its operation, and the new plant is proving to be adequate for treating the Telluride ores. The construction of this mill, it is estimated, will make it possible to treat much low-grade ore profitably at this property that otherwise could not be mined.

Butte & Superior Gets Butte-New York Claims by Foreclosure

Charles Bocking, general manager of the Butte & Superior Mining Co., has bid in the properties of the Butte-New York Copper Co. at Butte for $150,000. Mr. Bocking was the only bidder. The purchase includes the Colonel Sellars, Pollack, Bird, and Florence claims, close to the Black Rock claim of Butte & Superior, and the East End, Big Jumbo, and Paymaster claims, at Argenta, near the old camp of Bannack. The sale was made to cover foreclosure of bonds, which Butte-New York could not redeem, these bonds amounting to $150,000, nearly all of which it is believed are held by Butte & Superior interests. The total amount of execution, including interest, was $240,446.45. Butte & Superior has been running a crosscut into Butte-New York ground, and although no commercial ore has been encountered, prospects are said to be encouraging.

Trail Ore Shipments

Ores received by the Consolidated M. & S. Co. of Canada at its Trail smelter for the period Feb. 22 to 29 inclusive were as follows:

Name of Mine	Locality		Tons
Bell	Beaverdell	B.C.	37
Galena Farm	Silverton	B. C.	39
Knobhill	Republic	Wash.	103
Lone Pine Surprise			
Last Chance	Republic	Wash.	118
Monitor	Three Forks	B. C.	34
Millie Mack	Burton	B. C.	26
Quilp	Republic	Wash.	167
Roseberry Surprise	New Denver	B. C.	49
Ruth	Sandon	B. C.	50
Spokane Trinket	Ainsworth	B. C.	36
St. Eugene	Moyie	B. C.	29
Sally	Beaverdell	B. C.	39
Silversmith, lead	Sandon	B. C.	157
Silversmith, zinc	Sandon	B. C.	146
Company mines	Various	B. C.	9,307
Total			10,337

Property of the Alaska Minerals Co. The mill is shown in the foreground to the right

Alaska Minerals Co. Opens Good Ore in Hersey Mine

The Alaska Minerals Co., organized last year in Anchorage, Alaska, has met with success in the development of the Hersey mine. Crosscutting from the lower tunnel proved that the original owners had been deceived by a small fault and had driven the tunnel along the gouge of a fault and failed to find the ore.

When the new work cut the vein on this level it was found to have a width of 18 in. of gold ore averaging about $65 per ton. Much ore was then developed by raising to the upper levels, and an experimental mill-run was made on 250 tons of the ore, which netted a bullion recovery of $6,000. A permanent camp has been established, development work is moving ahead, and a ten-stamp mill is being installed. Sumner Smith, who heads the company, estimates that he now has five years' reserve ore in sight for this mill. Water power is being developed to operate the mill and a small compressor for underground service.

American Gold Dredging Co. Abandons Redding District

The American Gold Dredging Co. has abandoned its dredging ground close to Redding, Calif., and is now dismantling the dredge, which operated since 1918 but which did not secure a profit from the low-grade gravels. The company has not been prosperous and its affairs are now being put into condition for withdrawal from the gold-dredging business.

Verde Central Sinks and Raises to Complete Main Shaft

Rapid progress is being made at the Verde Central mine, at Jerome, Ariz., with the sinking of the new working shaft. Raises have been completed from the 1,000 level to the 800 level, and from there to the 600 level the raise is about finished. The shaft is completed to the tunnel level, a distance of 125 ft., and the raise from the 600 level is up about 300 ft. It is estimated that the shaft will be completed down to the 1,000 level by May, and at that time sinking will be started to the 1,600 level. Surface construction is progressing satisfactorily, and it is expected that the permanent headframe, hoist, and other equipment will be ready by the time the shaft is completed.

Drilling South of Joplin, Mo., Proves Some Good Ore

Considerable activity continues to be reported in the vicinity of Seneca and Spurgeon, Mo., south of Joplin about 10 miles. The St. Louis Smelting & Refining Co. has taken leases on 720 acres of land in this neighborhood and has started prospect drilling and has made several good strikes of lead ore at shallow depth. A. O. Rose and associates, of Joplin, are planning to build a small mill on the Allen land, near Spring City, a few miles north of Seneca. It is expected that silicate will be the principal product. A number of small companies have begun operations on land east of Spurgeon and are getting shallow silicate.

A "close-up" of the building at the Hersey mine, a typical camp in Alaska

News from Washington

By PAUL WOOTON
Special Correspondent

Scientific Tariff Specialists Would Keep Copper on Free List

Interests of Public at Large Would Suffer from Copper Tariff, They Say—Growing Export of Electrical Manufactures Significant

ACTION by the President under the flexible provisions of the Tariff Act in increasing by 40 per cent the duty on imports of wheat has resulted in renewed discussion of scientific tariff making, and a possible tariff on copper is being considered.

Despite the fact that the United States Tariff Commission is working under great limitation in the matter of authority and the restrictions placed upon its fact-finding activities by the small appropriation allowed that body, it is generally admitted that the creation of the Tariff Commission marked decided progress in the trend toward scientific tariff making. Another important step was taken when the power was granted to alter rates as conditions change.

For some weeks tariff specialists in Washington have been watching with interest the discussion as to the advisability of applying the principle of tariff protection to the domestic copper-mining industry. The predominant opinion seems to be that the welfare of the public at large will be best served if copper remains on the free list. The ideal condition, it is pointed out, would be to export no raw material. If the maximum amount of our raw materials are to be converted into manufactures in this country, American manufacturers must have the advantage of as low raw material costs as have their foreign competitors. The increasing volume of our exports of electrical equipment, automobiles and other products containing a high percentage of copper, in addition to our manufactures of the metal itself, is cited as the best indication of the wisdom of having copper on the free list.

On the other hand, however, there are some who point with apprehension to the potentialities of Chile and South Africa as producers of low-cost copper. They see no menace to our foreign trade by the application of a duty, since the lowest priced foreign copper always is available to American manufacturers through the operation of the customs drawback. The point is made that, in the effort to produce copper on a very large scale so as to reduce costs to the point where we can compete with foreign copper, a great natural resource is being drawn upon heavily at a very small margin of profit. In that connection, the point also is made that were a portion of the American capital and the American brain, now engaged in efforts to bring the production of a relatively high-cost American copper to a point where it can compete with the foreign production, transferred to the development of foreign properties susceptible of low-cost production, it would be better in the long run.

Another point made in the discussion of the copper situation is the fact that developed copper mines cannot be held in a "stand-by" condition. They must be operated, or they will deteriorate seriously. Whether a duty would help the copper mining industry is debatable; it seems clear, however, that something must increase the current market price of the metal if the higher cost mines are to continue operation.

Oddie Will Press Bill for New War Minerals Appropriation

After conferences with the War Minerals Relief Commissioner, Senator Oddie and Representative Robison, the chairmen of the Committee on Mines and Mining in the Senate and House of Representatives, respectively, have determined to press for early consideration a bill authorizing the appropriation of $2,500,000 to be used in the payment of such war minerals claims as may be found to come lawfully within the War Minerals Relief Act. The bill, as drafted, provides that only such part of the additional appropriation as may be necessary is to be used. The supposition is that the entire amount will not be required.

No criticism is heard of the policy of the Secretary of the Interior in withholding payments, since court decisions as to purchase of property and interest payments interposed uncertainty as to the adequacy of the appropriation now available. If the Supreme Court of the United States should reverse the decisions of the lower courts and relieve the government of the requirement of reimbursing claimants for losses in property purchases and of interest payments, the remainder of the original $8,500,000 will be adequate to pay such awards as are likely to be made in all pending claims.

Bauxite and Copper Imports Increased in January; Lead Less

The quantity of bauxite ore imported into the United States during January, 1924, was about 43 per cent greater than the monthly average for the year 1923, according to the Department of Commerce.

January's imports of antimony ore were but slightly over 5 per cent less than the monthly average for 1923. There was, however, a much greater decrease in the quantity of antimony metal imported during January, its imports being about 51 per cent less than the monthly average for last year.

Imports of unrefined copper were about 9,076,000 lb. greater than the monthly average for 1923. Imports of lead pigs and bars were about 3,335,000 lb. less than the monthly average for last year.

Johannesburg Letter

By John Watson
Special Correspondent

Gold Output for 1923 Best on Record Except 1916

Total 9,133,060 Oz.—More "Boys" Working—Government Areas Leads in Profits

Johannesburg, Feb. 4—The Transvaal gold output for December was declared on Jan. 10 as 778,849 oz., having a realized value of £3,660,590. Although December had five Sundays and the Christmas Day stoppage, the daily average, 31,154 oz., was a record for the year. Compared with November there is a decrease of 1,790 oz. The December output was valued at £4 14s. The total gold output from the Transvaal for 1923 was 9,133,060 oz., which is the second largest yearly output. The value of the 1923 gold was £39,894,743. In 1916, the record year, 9,296,618 oz. was produced. The native labor returns show 177,779 "boys" working on the gold mines, being an increase of 105 over the November figure. The following figures for December show results from mines earning highest profits:

	Working Costs per Ton		Tons Crushed	Value or Revenue, £	Estimated Profit, £
	s.	d.			
Government Areas	17	7.5	146,000	310,978	185,481
New Modder	17	5.4	113,000	242,131	143,532
Crown Mines	17	11.0	217,000	318,318	123,882
Modder B	19	11.1	65,000	149,153	84,405
Modder Deep	17	2.0	43,000	107,983	71,046
City Deep	23	4.9	93,000	177,198	68,331
Van Ryn Deep	19	6.6	62,500	125,889	66,067
Springs	22	10.7	59,500	120,579	52,477
Randfontein Central	18	9.2	202,500	238,868	50,090
Geduld	18	7.0	68,000	111,686	48,432
Brakpan	21	9.3	70,000	119,710	43,497

The Gold Producers' Committee of the Chamber of Mines has decided to grant a bonus to the employees of the mining industry; this is rendered possible by the recent rise in the gold premium and will come into force immediately. For every complete 6d. net price exceeding 90s. per fine ounce, a bonus of 1 per cent on wages (excluding overtime payments) limited to a maximum of 15 per cent, will be paid. No bonus is payable when the net price falls below 90s. 6d. per ounce. By "net price" is meant the average London price of gold during the first twenty-four days of the month in question, less average realization charges and taxation on premium. In the case of a man earning £30 per month, which is roughly the average pay on the mines, the bonus for January would be 6 per cent and he would receive £1 16s. bonus; in the case of a man earning £40 a month the bonus would be £2 8s. The bonus is not payable on earnings exceeding £40 per month; but such employees will receive bonus on the first £40 per month of such earnings.

Mexico City Letter

By W. L. Vail
Special Correspondent

Collapse of "Rebellion" Reassures Mining Interests in Republic

Exploratory Work Again More Active —French Company Plans Exploitation of Low-Grade Ore

Mexico City, March 1 — The spectacular collapse of the armed revolt against the government is reassuring to mining interests. Comparatively little damage was done mining properties. A few forced loans were collected, and the government put over its demand for advance taxes. In the main there is an air of mild optimism, and already exploration work, temporarily abandoned because of the uncertainty of the political situation, has been resumed in several parts of the country.

Large French companies have gone into the old Tasco district of Guerrero, and are preparing to work low-grade ores on a large scale. The Xitinge property is also being put in condition by the Real del Monte people. Tasco turned out millions in times past, and the camp has practically been abandoned for many years. Some activity is being shown in Guerrero, more particularly near the Balsas River, where transportation can be had. The districts of Zacualpan, Temescaltepec, and Sultepec, in the State of Mexico, have been working with little or no interruption, throughout the late unpleasantness.

In Michoacan, the Angangueo, a property of the American Smelting & Refining Co., is milling 30 tons daily and the concern is now increasing the capacity of the plant 50 per cent.

Record Production Cost at Fresnillo

The Mexican Corporation, at Fresnillo, continues to work steadily. The plant has a capacity of 3,500 tons daily, and reserve ores of 7,000,000 tons, said to average assay 170 gm. silver and ¾ gm. gold at the surface. At depth the silver content is higher. Cyaniding gets practically 80 per cent of the assay values. The cost of extraction has been reduced to about 3.70 pesos per ton. This appears to be a record breaker in Mexican milling.

The Real del Monte properties in the Pachuca district are extracting approximately 95,000 tons monthly, with 45 to 47 tons of silver bullion. The Santa Gertrudis is producing 70,000 tons, mostly from subsidiary properties, as the original property is practically worked out. The San Rafael, also in the same district, is turning out 10,000 tons, and La Blanca is confining itself to development work on a small scale in the hope of striking new bodies of ore.

In the district of El Oro, State of Mexico, the Esperanza Mining Co. is actually producing about 1,000 tons of ore monthly. This company is attempting financial arrangements to increase the plant capacity. In the meanwhile operations have been reduced to a minimum. The El Oro Mining & Ry. Co. is turning out about 35,000 tons monthly, working on a low-grade ore, but due to the modern methods of extraction the company has been profiting. At Dos Estrellas (Tlapahuala) the company is getting out about 45,000 tons monthly and is now increasing the mill capacity 2,000 tons per month.

Reports from the west coast state that operations were interrupted somewhat during the rebellion, on account of interference with transportation. As the field has been cleared, work is being rapidly resumed, especially in the sections out from Guadalajara.

Recent government statistics show that taxes on mining properties for 1923 produced over 2,000,000 pesos, and the income from duties on metals exceeded 5,000,000 pesos. In some instances, the government has waived tax payments on properties within the zone of rebel activities.

A number of smaller companies are preparing a bill of damages against the government on account of alleged destruction of properties, or loss of profits, due to temporary closing down of work.

Government and Girand Jockey for Position on Colorado Project

Construction work on the Diamond Creek power dam on the Colorado River, that is estimated to cost $36,000,000, is progressing. The Colorado River Engineering and Development Co., generally believed to have the backing of certain individuals connected with the big copper companies of Arizona, has been doing the work under the direction of James B. Girand, who says: "Work was begun on this project Dec. 22, 1923, and has consisted of drilling a series of holes which will be blasted out to form the seat of the east abutment of our dam. We have complied with all the laws of the United States and the rules and regulations of the Federal Power Commission."

The government has made an effort to halt this work, and at 4 p.m. on March 1 filed an application to prevent the issuing of a license to Mr. Girand to carry on construction on this project. In reply to this move, Mr. Girand is quoted as saying, "I am legally entitled to a license, and you can say that we are going to resist the government's efforts to enjoin us from proceeding with the work at Diamond Creek."

London Letter

By W. A. Doman
Special Correspondent

Seek Gold and Copper in Eastern and Central Africa

Prospector a Pioneer as Frontier Advances—Bwana M'Kubwa Much Discussed

London, Feb. 22—Eastern and Central Africa are much in the eye of the mining public, for various reasons. As the white man proceeds further inland, the prospector becomes more in evidence, and the report of one discovery stimulates interest in other directions. The Livingstone Mountains, northeast of Lake Nyasa, are claiming attention at the present moment, outcrops of gold-bearing reefs having been located. It is not always easy to obtain trustworthy information, but it is said that the Anglo-American Corporation of South Africa has had a representative in the Livingstone Mountains district for some time, the results of whose work are so encouraging that there is talk of dispatching a properly equipped expedition. It is further reported that a quartz reef has been discovered in the Lolgorrien district, just south of the border of Kenya Colony, that many prospecting licenses have been issued, and that, although the reef does not exceed 1½ ft. in width, assays have reached 2½ oz. gold.

The above is from the gold standpoint. Base metals, so far, appear to be the more valuable, and if I mention Bwana M'Kubwa again (Northern Rhodesia) it is because financiers and engineers are talking Bwana. Earlier in the week it was reported that Edmund Davis had arranged with the Anglo-American Corporation, the Union Corporation, and the Consolidated Gold Fields to purchase a large block of Bwanas. So far as the Union Corporation is concerned this is incorrect, and as regards the Anglo-American Corporation the report may have had its origin in the purchase by Sir Ernest Oppenheimer, the chairman, of a substantial interest in the company. Whether this reported purchase is "P/A" or for the company, is not clear.

A. Chester Beatty still thinks well of

Bonanza Gold Diggings in Amur Province, China, Produce $1,250,000 in Four Months

Special Correspondence from Amur, China

THE recovery in four months of more than $1,250,000 in placer gold from alluvial deposits recently opened by the Fong Yuan Gold Mining Co. in Amur province, China, has created great excitement among the Chinese, and something of a stampede is expected before next season. According to Kwong Wu, president of the Kwang Tu Government Gold Mines, the rich deposits are situated 50 miles northwest of Helampo, on the Amur River. The ground worked thus far is a strip about 800 ft. wide and one mile long. Seven thousand Chinese miners were engaged, presumably on a share basis, the gold being recovered by the most crude methods. Kwong Wu believes that the installation of a dredge or other modern equipment will greatly improve the percentage of recovery and will permit of increased production. The stockholders of the Fong Yuan company received $10,000 for each share last year.

Rand Gold Output for January Second Highest in History

THE gold output from the Rand mines, in South Africa, during January amounted to 796,768 oz., which, with the exception of October, 1915, is the best monthly output on record. In that month 797,631 oz. was produced, according to cabled advices to the Department of Commerce. The price realized was 95s. per ounce, an increase of 2s. 6d. compared with December. The value of the January production totaled £3,784,648, an increase of £182,472 over December, 1923, and £497,432 over January, 1923.

the company. He tells me that a pilot plant has been running on the Perkins process for some time, and that from 3½ per cent ore between 91 and 92 per cent extraction has been obtained. Everyone apparently is satisfied, and the question of erecting a 1,000-ton plant is being discussed. This, it is estimated, could be installed for approximately £450,000. It is officially believed that costs will be on such a scale as to enable the Bwana company to produce copper to compete with the American low-grade properties. The idea seems to be to produce the refined metal on the spot. With the Bwana M'Kubwa ore reserves are now (by its purchase from Chester Beatty's company) linked up the reserves of the N'Kana mine, and it is expected that in the not distant future there will be approximately 10,000,000 tons of ore from which to draw. There are no difficulties about transport facilities, and coke will probably be obtained from the Wankie colliery, one of the Edmund Davis group.

Falcon Mines (Rhodesia) worked at a loss last year, and so far there seems little prospect of an improvement. Extraction was better:

	Copper, per Cent	Gold, per Cent	Silver, per Cent
1921-22	85.8	78.9	76.6
1922-23	87.8	80.8	78.7

From 193,542 tons of ore averaging 4.14 dwt. gold, 8.74 dwt. silver and 1.9 per cent copper, the recovery was 3,285 tons of blister, of a value of £303,355. Working costs were £360,337. Development was disappointing, and reserves at June 30, 1923, were only 246,000 tons, averaging 3.3 dwt. gold and 1.6 per cent copper.

Eagle-Picher Develops Mabon Tract

It is expected the Eagle-Picher Lead Co. will push development drilling operations on the 400-acre tract of the Mabon land, south of Century, Okla., which it recently purchased at an announced purchase price of $100,000. Although the land is contiguous to some that has produced much ore, it has never been mined or even thoroughly prospected. It was owned previous to its purchase by the Eagle-Picher company by J. S. Mabon, of Miami, Okla., one of the pioneer operators in the field.

Nickel Plate Mill in British Columbia Restarted

The Hedley Gold Mining Co. restarted its Nickel Plate mill, at Hedley, on March 1, and will employ between fifty and sixty men during the present season. This mine has contributed largely toward the lode-gold production of British Columbia, having produced nearly 500,000 oz. During the war, however, owing to a scarcity of men and a desire to make as large an output as possible, development work was neglected, and the company has not been able to catch up with the ground then lost.

During the last two years considerable exploration has been done with diamond drills, and, though much of the work has been negative, some extensive deposits of ore ranging in value between $10 and $20 per ton have been located. Some milling has been done during the summer months during the last two years, and it is hoped that this year the mine will again find a place among the principal producers of the province. Besides gold, the mine has produced a considerable tonnage of arsenical concentrate, which is treated at the smelter at Tacoma.

Will Adapt Salida Smelter for Gordon-Process Plant

General Metals Recovery Co. Plans to Treat Complex Zinc Ores—Gas-House Liquor Utilized

The General Metals Recovery Co. has been organized to take over the old Ohio-Colorado smelter at Salida, Colo., which is to be adapted to the reduction of complex zinc ores by what is termed the Gordon process.

Extensive tests at the experiment plant of the Colorado School of Mines have convinced several Colorado metallurgists and smelter men that gas-house liquor, the waste product from the gas plants, which is highly impregnated with ammonia and ammonia salts, is an efficient and cheap solvent of zinc and copper, and that through its use it is possible to extract these metals from the ore, leaving it in a desirable form for the smelter or for chemical extraction of other metallic values. These men have taken over the Salida plant and are planning to remodel it for the adaptation in a commercial way of the Gordon process for the treatment of complex zinc ores of the Leadville district.

An outline of the process comprises a preliminary roast at a low temperature, but sufficient to break up the sulphides of zinc to oxides and sulphates. The maximum temperature, 650 to 700 deg. C., will make oxides of all the other metals, some zinc sulphate being the only sulphur compound left. After roasting, the ore is introduced into closed agitators with gas-house liquor, and in a reasonable time the zinc and copper goes into solution, sulphate and oxide of zinc and oxide of copper being all soluble. The lead, gold, silver, iron, manganese, and gangue are insoluble. This insoluble material is washed by counter current as in cyanide practice, and is ready for the regular smelter in a desirable form and at low treatment charge. It is also considerably concentrated by the roast, by the loss of sulphur and the extraction of the zinc, so that fewer tons are treated by the smelter in obtaining the lead, gold, and silver. A raw ton (2,000 lb.) will average about 1,200 lb. of smelting material. After separating the pregnant solution containing the zinc and copper by decantation, it is delivered to a tank where metallic zinc is added, and the copper separates and is precipitated as slime copper, which is easily converted to metallic bars.

The solution containing the zinc only passes to a still, where live steam is introduced. The gas-house liquor, which is volatile, leaves with the steam and is condensed to solvent again for use in treatment of another charge in the agitators. The zinc precipitates as basic carbonate, of 56 to 57 per cent zinc content, and on drying and calcining produces an oxide which is chemically pure. This pure zinc oxide is now ready to be converted into high-grade zinc oxide or metal.

The problem of economically treating complex ores of lead and zinc is the biggest facing Colorado mining.

Bonanza Ore in Talapoose Mine, Lyon County, Nev.

IT IS REPORTED that Ferretto & Ferretto have opened a shoot of high-grade ore, carrying mostly gold but some silver, in a lease on the Talapoose mine. This mine is located about 15 miles northeast of the Comstock, in northern Lyon County, Nev., just east of the camp of Ramsey. The oreshoot was found in following a small cross vein, which crosses the main tunnel about 400 ft. from the portal. This gradually widened until last reports are that the face of the drift shows four feet of ore which will run between $400 and $500 per ton. The ore is being sacked preparatory to shipping.

Court Grants Utah-Apex Surface Rights to Utah Copper

The Utah Copper Co., which for some time has been seeking to obtain surface rights at Bingham, Utah, in certain claims owned by the Utah-Apex Mining Co. in order to use the ground for dumping purposes, has been awarded immediate possession. This is granted by a decision handed down by Judge Tillman A. Johnson, of the United States District Court, pending final decree, in which he will appoint a referee to determine the value of the condemned surface land. Counsel for the Utah Copper Co., which had filed condemnation proceedings, told the court that the two companies had not been able to agree as to compensation. The proceedings do not in any way effect the mineral rights. Portions of the following mining claims are involved: Exchange, Jack Rabbit, Stanley, Tilden No. 6, Grand Cross, Lookout, Coramandel, Fraction, Andy, Tilden No. 5, Parvenu, Tilden No. 2, Mellon and Tilden No. 4.

MEN YOU SHOULD KNOW ABOUT

Augustus Locke, of San Francisco, is at Calumet, Mich.

Charles E. Rogers, of London, expected to sail for New York on Friday, March 14.

A. C. Wilson has been appointed superintendent of the Moore Mining Co. at Jackson, Calif.

W. E. Simpson has left Swastika, Ontario, for Europe. He will be gone about three months.

C. E. Crawford, of Silver City, N. M., will be in Guanajuato, Mexico, for two months on geological work.

H. W. Davis is collecting statistics on fluorspar for the U. S. Geological Survey in Illinois and Kentucky.

Clyde A. Heller, president of the Tonopah Belmont Development Co., has been in Reno and Tonopah on company business.

M. N. Bramlette, of the U. S. Geological Survey, is in Kansas to begin oil and gas investigations in co-operation with the states.

William T. MacDonald, mill superintendent of the Moctezuma Copper Co., at Nacozari, Sonora, Mexico, was recently in San Francisco.

Robert S. Lewis, professor of mining of the University of Utah, will present a paper on mine ventilation at the April meeting of the Utah Metal Mine Institute.

Gerald Sherman, superintendent of mines for the Phelps Dodge Corporation, has returned to Bisbee, Ariz., after completing an inspection of company properties at Morenci.

F. H. Curry, for the last three years superintendent of concentration for the Union Minière du Haut Katanga, has arrived in New York en route to his home in Topeka, Kan.

A. Brookbank has gone to Fourniere Township in the gold area of northwestern Quebec, in the interests of John Taylor & Sons of London, traveling 80 miles by dog team.

Stephen Kaffer is acting field superintendent for the Estrella Mining Co. and may be addressed at Bacis, Durango, Mexico, where the company is conducting a development campaign.

Maurice W. Summerhayes, of the Crown Reserve, has been engaged as consulting engineer for the Barry-Hollinger mine, of Boston Creek, Ont., and has taken full charge of the property.

James Houston has been engaged as manager of the Shannon-Goodfish, a newly incorporated company which will operate claims in the Goodfish Lake section of the Kirkland Lake district.

Jesse P. Crawford announces that he has resigned as customs assistant to the Assistant Secretary of the Treasury in charge of revenues, and has become associated with a New York law firm.

F. H. Hatch, Prof. Henry Louis, Frank Merricks, F. W. Harbord, and **Sir Kenneth W. Goadby** are members of the reconstituted British Advisory Committee for the Metalliferous Mining Industry.

Frank Corwin, who has been superintendent of the Humboldt smelter for the last seven years, has resigned that position and is now on the staff of the United States Metals Refining Co., at Carteret, N. J.

S. H. Worrell, formerly dean of the Texas State College of Mines at El Paso, Tex., has returned to the State of Sonora to take charge of the Monte Cristo mine, of which he is general manager.

E. W. Westervelt, of Rochester, N. Y., has been visiting Ymir, B. C. He was the guest of **W. T. McDowell,** manager of the Yankee Girl mine. Some years ago Mr. Westervelt was the superintendent of this mine.

Heath Steele

Heath Steele, president of the Compañia Minera de Peñoles, S. A., at Monterey, N. L., Mexico, will return from Mexico to New York in the early part of May, when his headquarters will be at the offices of the American Metal Co., 61 Broadway, New York City.

Dr. Walter S. Palmer, acting director of the Mackay School of Mines at Reno, has returned to Reno after attending the meeting of the American Institute of Mining and Metallurgical Engineers in New York on Feb. 18 to 20.

Walter Harvey Weed has just returned from a visit to the Porcupine gold field, in Ontario, in the course of which he inspected the McIntyre, Ankerite, and Paymaster mines to obtain geological information concerning these properties.

George L. Cristian has resigned as mining enginer for the Tonopah Extension Mining Co., and has accepted the position of chief of the engineering department of the Tonopah Belmont Development Co., taking the place recently vacated by the removal of R. A. Gillern to Los Angeles.

George H. Harbordt, vice-president and general manager of the Compañia Minera de Peñoles, has left Monterey, Mexico, for a visit to various smelters in the western part of the United States. He will also visit New York, and the American Metal Co.'s smelter and refinery at Chrome, N. J., before returning to Monterey.

W. M. Brewer, resident mining engineer for southwestern British Columbia, speaking recently to members of the British Columbia Chamber of Mines in Vancouver, told of unexplored and promising sections of his district and expressed the hope that Canadian capital would show more interest in the development of the mineral resources of the country.

G. D. B. Turner, of the Indian Mines, Ltd., in addressing the British Columbia Chamber of Mines recently, in Vancouver, said that it had taken him eighteen months to prove that he had a mine in the Indian property. He had established depth on an orebody averaging $25 a ton in value and was proceeding with its development. A mill will be installed and a three and one-half mile rope tramway constructed.

Orvil R. Whitaker and **C. Q. Schlereth,** mining engineers, have formed a firm for a general consulting and managing business. Mr. Whitaker has been in the consulting field for several years, and Mr. Schlereth has been until recently general manager for the San Francisco Mines of Mexico, Ltd., Parral, Chihuahua, Mexico. The offices of the firm are at 932 Equitable Building, Denver, Colo., and 25 Broad St., New York City.

Robert Peele recently returned from a three months' trip aboard, most of which time was spent in Spain. In Madrid he spent some time at the Government School of Mines, which he says is now a flourishing institution, with a good teaching staff, fine equipment, and a large body of students. The mining industry of Spain, according to Prof. Peele, has become more active in the period during and following the war.

Frank Oliver, of New York, is making an examination for New York interests of the Orlean mine, at Hornsilver, Nev. This mine was recently acquired by the Victory Divide Mining Co., of which A. I. D'Arcy, of Goldfield, Nev., is president. Mr. Oliver will be several weeks in Nevada, making his headquarters at Goldfield. He was formerly manager of the Florence Goldfield mine at Goldfield and of the Le Roi mine at Rossland, B. C.

E. C. Saint-Smith, of the Queensland (Australia) Geological Survey staff, has been appointed general manager of a company, with a capital of £450,000, lately formed by W. H. Corbould to acquire and work several of the most important leases on the big Mount Isa silver-lead field, Cloncurry. Mr. Saint-Smith, who graduated in mining, metallurgy, and geology at the Sydney Technical College, New South Wales, has had a wide experience of mineral fields throughout Australia. Since joining the Mines Department of this State he has written a large number of lucid and valuable reports on the geology of different mineral fields, and on separate mines, including the Sardine, Canary, and others on the Kangaroo Hills fields. His latest were two reports on the Mount Isa field, and one on the Nightflower field in the Chillagoe district. The government has granted him twelve months' leave, so that if he wishes to return to the Mines Department at the end of that period he can do so.

Societies, Addresses, and Reports

Canadian Mining Institute Meets at Toronto

Twenty-sixth Annual Gathering Proves Particularly Successful, Though Active Conditions in the Field Keep Many Members Away

By Edward H. Robie
Assistant Editor

TORONTO proved no less a magnet than Montreal as a convention city, when 220 members of the Canadian Institute of Mining and Metallurgy gathered there on March 5 to 8 for their twenty-sixth annual general meeting. This number represents about 15 per cent of the total membership of the Institute and associated societies and was considered a most satisfactory showing, considering the fact that the gold, silver and nickel mining industries of northern Ontario are now so active that representation from that district was not as good as usual. The technical sessions were held in the Pompeian room and an adjoining smaller room of the King Edward Hotel; the acoustics of the larger room and the facilities for showing lantern slides in the daytime are poor, so that it is not above criticism for a meeting of this kind. Nevertheless, the technical sessions were extremely well attended.

The social side of a convention is, to our mind, the most important, for it is there that one becomes better acquainted with his fellow workers and learns details which often never get into published articles. In this respect, meetings of the Canadian Institute are notable, the present one being no exception. In addition to the informal and enjoyable meetings held at various points between the second and fourteenth floors of the hotel, a smoker with a play and wrestling and boxing bouts was arranged for Thursday evening, an afternoon reception at the Royal Ontario Museum on Friday afternoon, and a banquet on Friday evening. A luncheon to have been given by the Toronto Board of Trade was cancelled for reasons unknown; it was suggested by one member that had the meeting been opened by the Mayor of Toronto instead of by the provincial Minister of Mines, the program might not have had to be altered.

Members Visit Oshawa

The excursion to the neighboring city of Oshawa on Saturday, arranged by Robert A. Bryce, attracted about fifty members and proved one of the most enjoyable trips ever planned for an Institute meeting. The General Motors of Canada, Ltd., was a particularly gracious host, and in addition to an inspection trip through the plants, where Cadillacs, McLaughlin - Buicks, Oldsmobiles, Oaklands, Chevrolets, and G. M. C. trucks are manufactured, 5,000 men being employed, an appetizing lunch was offered the visitors. Following this, several speakers were introduced by President McLaughlin of General Motors. In the afternoon, a car was provided for a tour of the city and a visit was paid to the new plant of the Ontario Potteries, Ltd., where semi-porcelain ware is, for the first time, being manufactured in Canada, from Saskatchewan clay. The method of forming cups, saucers, pitchers, plates and other ware was exhibited; also the method of burning the clay and decorating pottery and glassware.

The technical sessions were somewhat weak in papers giving details of mining and metallurgical methods, most of those read having to do with the general economics of the mining industries of the country, or being descriptions of individual mineral deposits. The most general topic of discussion was the dependence of Canada on foreign mineral supplies; suggestions for remedying this condition were freely expressed, and it was the general opinion that the future of the Canadian mineral industries is brilliant, dissenting rumblings from the Pacific Coast to the contrary notwithstanding.

As is the customary practice, the first meeting, on Wednesday morning, was devoted to general business and to the presentation of mineral statistics for the preceding year. The Hon. Charles McCrea, Ontario Minister of Mines, opened the proceedings with assurances of government co-operation with the mining industries of the province, equitable taxation, and fair legislation. The same note of co-operation between the operators, government, and the Institute was struck by J. A. Dresser in his presidential address.

Mineral production in Ontario was valued at $68,000,000 in 1923, compared with $62,000,000 in 1922, the principal items of increase being copper, nickel, platinum metals, lead, white arsenic, graphite, pyrites, mica, and quartz, though some of these are produced in only small amount. Gold and silver production was substantially unchanged. In Quebec, the value of mineral production increased from $18,000,000 to $20,000,000, asbestos being the principal product.

Dr. W. G. Miller presided over the Thursday afternoon session, in which three papers were offered: "Some Economies Effected on Canadian Mining Statistics," by S. J. Cook; "Mineralography as an Aid to Mining," by Ellis Thomson; and "The Value of Topographical and Geological Maps," by K. G. Chipman. The first-named was distributed in printed form. In Canada, all statistics are gathered and published by one organization which has taken over the work formerly done in this branch by the Geological Survey, the Department of Mines, the Census Office, and other branches of the government.

Professor Thomson, of the University of Toronto. illustrated his remarks by numerous lantern slides showing polished sections of ore specimens from various mining camps. The mircroscope is now considered a necessary part of the research equipment at all important properties, according to Professor Thomson, the results of microscopic examination being of value not only to the geologist but to the mining and metallurgical engineer as well. The intimate nature of the association of pyrrhotite and pentlandite in the Sudbury nickel deposits was dwelt on particularly, even a 300-mesh particle containing both minerals. Separation by the usual ore-dressing methods is obviously impracticable on material of this kind. Platinum minerals have been isolated in these deposits by microscopical means, but the palladium mineral is yet to be found.

The importance of the topographical and geological maps prepared by the Geological Survey during the last eighty years was disussed by K. G. Chipman.

A technical session was also held on Wednesday evening, at which two papers were presented: "The Minto Coal Basin of New Brunswick," by W. S. Dyer, and "Oil and Gas in Ontario," by R. B. Harkness. The motion pictures made at the University of Toronto by H. E. T. Haultain and F. C. Dyer, illustrating the action in a ball mill and in roll crushing, were also exhibited. Some additions have been made during the last year and the present edition aroused the same interest as has been evinced at the former showings.

Search for Potash in Western Canada Described

The "Sodium and Magnesium Salts of Western Canada" was the subject of an extensive paper by L. Heber Cole, of the Canadian Department of Mines, which was presented at the Thursday morning session. In the last three years a great deal of work has been done on the alkali lakes of the western provinces by the government. At first it was thought that potash might be found, but so far no potash lakes of economic importance have been discovered. However, some outlet may be developed for the large quantity of mixed sodium and magnesium sulphates that are present. There are also small quantities of the chloride and carbonate of sodium, and of the sulphate and carbonate of calcium. Mr. Cole described some of the deposits that have been investigated, discussing methods of drilling, recovery and refining, illustrating his talk with lantern slides. One of these showed the surface of the alkali thickly covered with a plant having magenta-colored flowers, the *salicornia herbacia*, which seems to thrive on what might be called such a laxative soil. The plant burns to about 8 per cent ash, of which only 6 to 8 per cent is said to be sodium compounds.

The author of a scheduled paper on "Malagash Salt Deposits," A. R. Chambers, was not present, so this was omitted. "The Iron Ore Situation in Ontario" was then discussed by G. W. MacLeod, his paper having been issued in printed form. Canada ceased to be a producer of iron ore in 1921 when the Magpie mine closed down. The importance of iron to the industrial life of a nation was stressed, among the authorities quoted being Arthur B. Parsons in a recent number of the *Engineering and Mining Journal-Press*. Canada has no commercial bodies of

Some of those present at the Toronto meeting of the C.I.M.M.

shipping ore but has many low-grade deposits, which, by treatment, can be made suitable for blast furnaces. Some of these deposits, and the methods of dressing considered suitable, were discussed. Mr. MacLeod referred to the report of the Iron Ore Committee which advocated the payment of a bounty on iron ore, and at the meeting a resolution was passed that the report be indorsed. There was no discussion of the economic disadvantage to the Canadian nation of paying a bounty for the production of low-grade ore from domestic deposits when plenty of high-grade ore is easily available from a friendly nation; only the advantages were mentioned.

Lead and Zinc Developments in Gaspé Peninsula Described

"Developing Zinc and Lead Deposits in Gaspé Peninsula" was the subject of an interesting paper presented by J. C. Beidelman, which was illustrated by lantern slides. The Gaspé Peninsula is that neck of land along the south shore of the St. Lawrence River projecting into the Gulf of St. Lawrence. Important discoveries of veins of sphalerite and galena were made here in 1910, and to date sixteen veins have been proved. A road will be completed to the property this summer, following which a concentrator and smelter will be erected for the production of pig lead and zinc oxide. The property, which is owned by the Federal Zinc & Lead Co. of Montreal, may possibly become one of the most important lead-zinc mines on the continent. Transportation has been the problem so far.

At the afternoon session on Thursday, Prof. H. E. T. Haultain, of the University of Toronto, read a short paper on "Research in Mining," emphasizing the fact that a great deal of research was being done all the time but not always under that name. "Developments in the Quebec Gold Belt," by W. and M. Goodwin, told of what has been done at the various properties in Rouyn and Destor townships. They show a marked diversity, both of type and occurrence. So far, lack of transportation and power have been the chief hindrances to development, but these can promptly be provided as soon as commercial orebodies are proved. An encouraging feature in the development of the district is the fact that well-established mining companies have taken over many of the best claims and prospects, thus assuring a fair trial and economical mining development. Mr. Goodwin's paper has been printed and is available from the Institute.

A paper by H. R. Davis described "A New Oil Well in Romney Township, Kent County, Ontario," which may be the forerunner of others of importance. Sherwin F. Kelly had a paper on "Electrical Prospecting in Canada," giving supplementary information to that contained in his articles published in the *Mining Journal-Press* and by the A.I.M.E. He is the sole authorized exponent in North America of the method devised by Professor Schlumberger, of Paris. Another method, that of Conklin, has been used at Joplin, and Mr. Kelly suggested that the Conklin method might work on deposits such as those at Kirkland Lake, to which the Schlumberger procedure is not adapted. At Porcupine, Cobalt, Sudbury, and in Manitoba, however, some interesting work has been done by Mr. Kelly, which is described in the paper above noted.

Opening the final sessions on Friday, C. V. Corless read what was probably the most ambitious paper given at the meeting, the subject being "The Mineral Wealth of the Pre-cambrian." This was a portion of a paper to be presented at the Empire Mining and Metallurgical Congress in London in June, designed to inform the mining engineers there gathered of what Canada has to offer in proved and probable mineral wealth. In it, Mr. Corless gave more credit than is his wont to the work of the geologists. A short paper with somewhat the same end in view was that of Balmer Neilly, on "Opportunities for Capital Investment in the Development of the Mineral Resources of Northern Ontario and Quebec." Considerable discussion followed. It was even suggested that a provincial lottery might not be a bad idea similar to that carried on in some Spanish-speaking countries, the money thus raised to be used in development of mining lands.

Deputy Minister Talks on Development of Mining Law

T. W. Gibson, in his discussion, told of the development of the mining law, which he considered had been along sound lines and such as to attract English capital. C. M. Campbell, of the Granby company, in British Columbia, had forwarded written discussion of the papers by Mr. Corless and Mr. Neilly, which was read by the secretary. Mr. Campbell has caused a great deal of comment recently by attacking the ideas of the optimists on Canada's mineral resources. He again made fun of the "unlimited resources" of Ontario, especially directing his remarks toward the optimism of Mr. Corless, of which, he said, Mr. Neilly was a poor supporter. Asked for a reply, Mr. Corless merely remarked that he had enjoyed Mr. Campbell's letter hugely.

Opportunities Offered in Manitoba Pointed Out

"Manitoba's Contribution to Canada's Mining Opportunities" was also discussed in a paper prepared by R. C. Wallace. He illustrated the various fields by lantern slides, and showed how some of the districts more recently in the public eye, in the vicinity of Rice Lake, were fairly accessible. The British Columbia opportunities, which were to have been described by H. G. Nichols and W. L. Uglow, were not touched upon, those men being absent.

Charles Camsell read a paper on "The Mineral Industries — Their present Place in the Commercial Development of Canada," which was well illustrated by charts showing that agriculture, livestock, and forest products are the three principal exports of Canada and that the mineral products exported from the country are yet in nowise equal to the imports. The deficiency, of course, is largely accounted for by the large imports of coal and petroleum. S. J. Cook also had a short paper.

The new president of the Canadian Institute is a comparatively young man—R. C. Wallace, of Winnipeg. He brings to the office the first Scotch accent that it has enjoyed for some time. The election is a highly popular one, as was evidenced by the reception which greeted his appearance at the annual banquet. At this function Charles McCrea was also among the speakers, pledging government support to the mining industries of the country. He will be among the representatives at the Empire Congress in London.

A scholarly word picture of Canada today by Sir Robert Falconer, president of the University of Toronto, will long be remembered by his hearers as a patriotic address of the highest type.

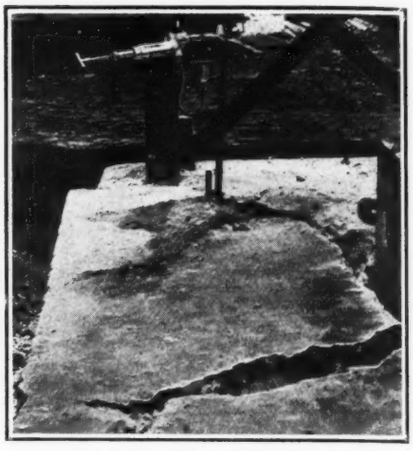
New Machinery and Inventions

Hydraulic Mining Cartridge Useful for Removing Concrete Foundations

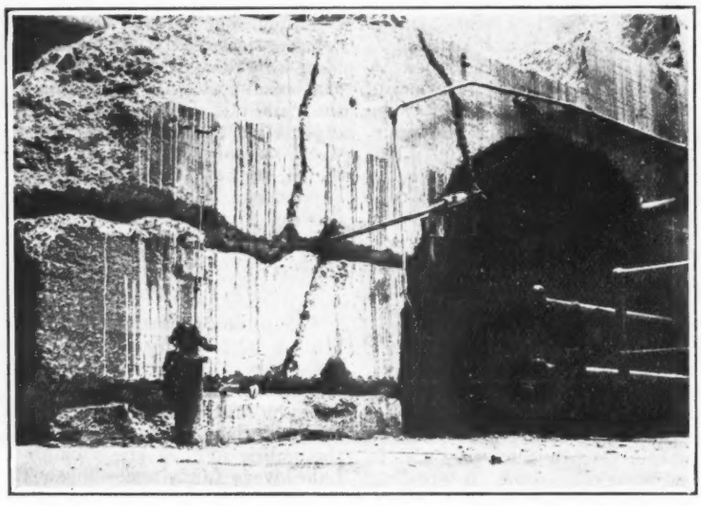
Blocks of Great Size Readily Broken From Mass and Split Into Smaller Pieces for Easy Handling

IN REMODELING plants, it is often necessary to break up large masses of concrete used as foundations to permit the installation of other machinery. This is not an easy task, particularly as explosives cannot be used for fear of damaging other equipment near by. Work of this sort can be facilitated, it is claimed, by a device termed an "hydraulic mining cartridge," invented in England by a Mr. Tonge. This device is controlled by the Demolition and Construction Co., 72-74 Victoria St., London, S.W.1, a representative of which company, B. C. Beauchamp, is in New York at present, stopping at the Ritz Carlton Hotel. The accompanying drawing shows the construction of the cartridge and the three photographs demonstrate the work that it will do. The following description of the cartridge has been furnished by Mr. Beauchamp:

"The hydraulic mining cartridge consists of a strong steel cylinder or cartridge-shaped body containing a number of small hydraulic rams or presses which work at right angles to the axis of the body. These rams were formerly of duplex or telescopic form, thereby having a longer travel. For practical work the solid ram has proved adequate to all requirements, while being somewhat simpler. The cartridge is used in conjunction with a pneumatic, steam, or electric drill. A hole of a suitable diameter, slightly larger than that of the particular size of cartridge being used, is drilled in the concrete from 2 to 3 ft. in depth. The cartridge is inserted in position, and liners, or packing pieces of flat iron bar about § in. thick, are placed between the heads of the rams and the concrete circumference of the hole. All is then ready for 'firing.' A priming charge of about a quart of water is required. The tank containing this is connected by a rubber tube to the suction side of the cartridge pump. This pump has two handles, the smaller of which is attached to the pump piston. Operation of this handle in and out alternately draws in water from the suction side and forces it into the cartridge head. An air exhaust valve is left open until the cartridge head, tubing, and pump are full; it is then closed. With the apparatus full of water it is now impossible to operate the small handle direct, and the second, and larger one, is brought into use. It comprises a screw device, which as it is tightened up forces water into the cartridge head past a non-return valve. As the operator continues to work the pump, therefore, the pressure behind the rams in the cartridge head gradually builds up, until finally the concrete cracks and then gives way. The usual hydraulic pressures employed in working the tool are from three to five tons per square inch, although much higher pressures could be used if required. However, since the collective area of the rams multiplied by the hydraulic pressure per square inch indicates a total bursting pressure of from 60 to 240 tons, depending on the size of the machine used, it is clear the need for higher operating pressures is non-existent for all practical purposes. One of the early applications of the machine was the lifting of 200-ton masses of concrete to permit of a chain being passed below them for removal.

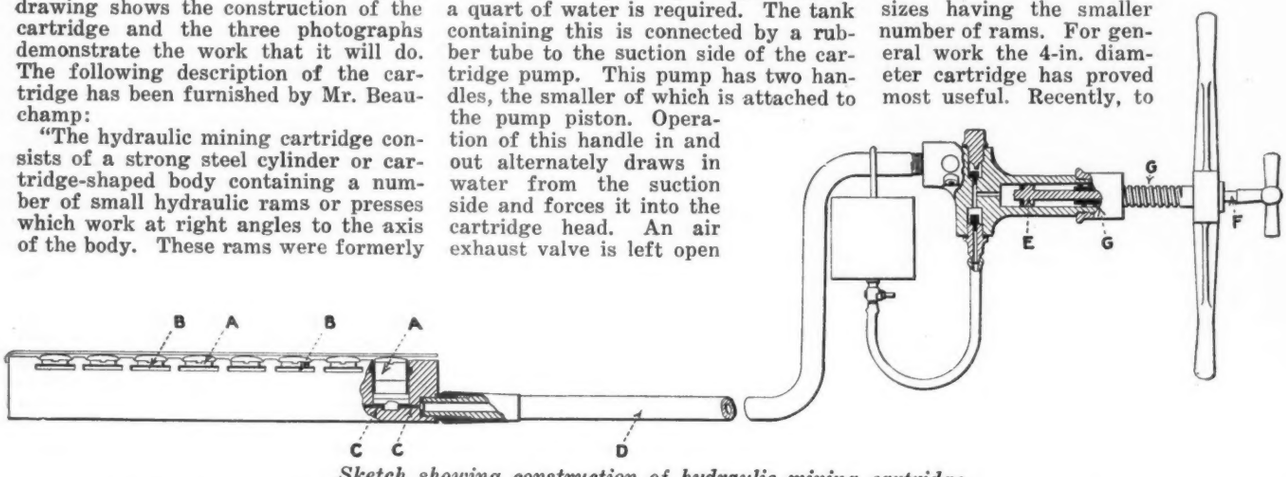


Breaking a large block of concrete



Hydraulic cartridge breaking fifty tons with one "shot" at Lots Road power station, London

"The cylindrical head of the cartridge is made of various diameters and lengths, and is provided with five, six, or eight press rams, according to the size of the tool, the larger sizes having the smaller number of rams. For general work the 4-in. diameter cartridge has proved most useful. Recently, to



Sketch showing construction of hydraulic mining cartridge

A, ram; *B*, retaining plate; *C*, passage; *D*, connection pipe; *E*, piston; *F*, piston rod; *G*, supplementary hollow rod

meet the requirements of small work, a baby cartridge of slightly over 2 in. diameter has been developed."

Other uses for the hydraulic "cartridge" will suggest themselves, such as quarrying and coal-mining work, for which it was primarily devised. It is, however, for work where explosives cannot be used that it possesses unique advantages. It is interesting to note that the cartridge was used in raising the two British warships that were sunk during the war in the Zeebrugge Canal to blockade it. By means of the cartridge the concrete with which these ships were filled was easily removed and the hulls were floated.

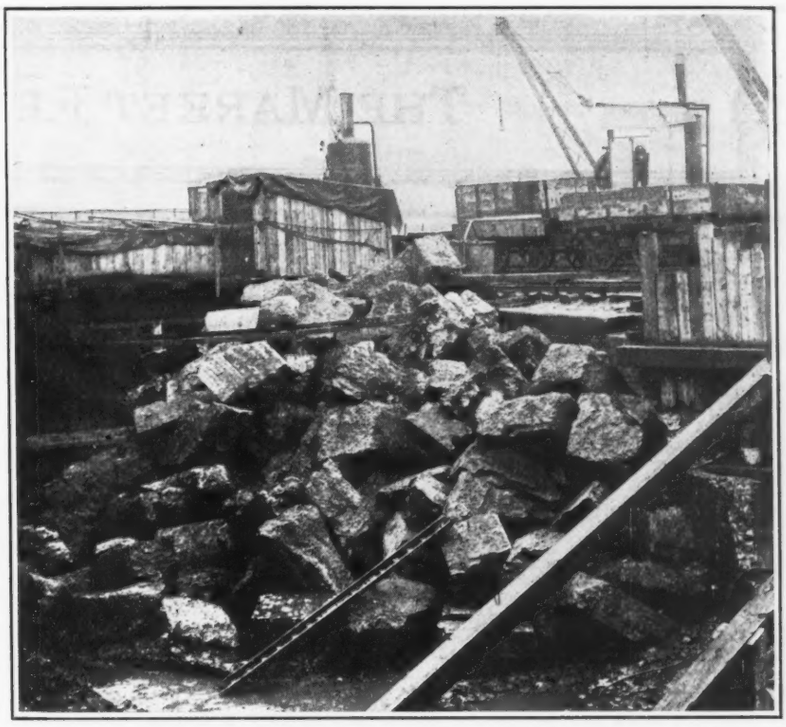
Monolithic Lining for a Reverberatory

At the plant of Goldsmith Brothers Smelting & Refining Co., in Chicago, the company has a condition where, for economy's sake, it has used firebrick linings, instead of magnesite brick. Due to the high corrosive action of the slag, the life of these linings averages less than two months, and the furnace has to be rebuilt at a cost of about $2,000 and with a shutdown of about ten days.

On Dec. 29 last a gunite lining was shot in this furnace where the condition was so bad that no further use could be made of the furnace until rebuilt. Several "hot spots" were showing in the outer shell. The lining that was placed over the existing brick in some places was as thick as six inches, and the mixture used was 45 per cent ground magnesite, 25 per cent thermolith, and 30 per cent fireclay. The first trials were without the fireclay, but it was found that an excessive rebound was occurring and that a more bonding material than the plain thermolith was needed to get the best results. The above mixture was then adopted.

It happened that immediately after the lining was shot an excessive cold spell struck Chicago, with the result that no work could be done at this plant, and the furnace was not put into operation until about four days after the lining was shot, and even with this handicap, and with the further handicap that when the work was done the existing air supply was very limited, the work was successful.

After the furnace had been in operation for six days, an inspection showed that there was not the slightest indication of a "hot spot" at any point of the shell.



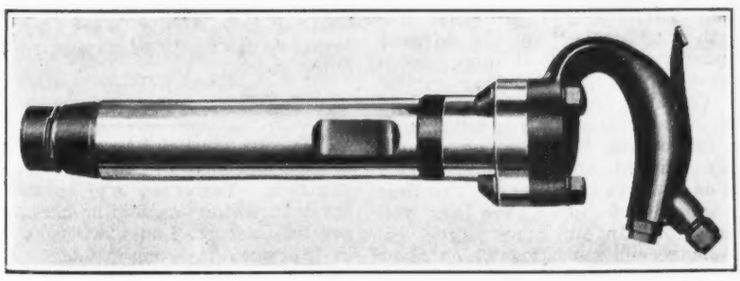
A pile of concrete blocks broken with hydraulic mining cartridge at Surrey Docks, London

Insulation Against Vibration and Noise

The Korfund Company, 42 Broadway, New York, has issued a pamphlet describing the use of foundation plates prepared from cork by its patented process, for the purpose of affording effective protection for both workmen and structure against the noise and vibration of machinery.

A New Riveting Hammer

A new type of pneumatic riveting hammer with improved features has been developed by Ingersoll-Rand Co., 11 Broadway, New York. The outstanding features claimed for this new riveter include bolted construction for holding the handle to the barrel, heavy section valve with liberal bearing surfaces; combination poppet and piston type throttle valve; power in excess of all ordinary requirements; low air consumption and easy operation. The new type hammers are manufactured in three styles and are available in a complete range of sizes from a 5-in. to a 9-in. stroke.



Low air consumption and easy operation are features claimed for this riveting hammer

TRADE CATALOGS

Insulation Tester. A leaflet of Herman H. Sticht & Co., 15 Park Row, New York, announces the Model D Megohmer, which combines a megohmmeter and direct-current voltmeter with a hand-operated direct-current generator.

Motors. A number of leaflets descriptive of motor equipment have been received from the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. Leaflet L.1765 covers motors for Westinghouse-Baldwin mine locomotoves (900 series); L.1908 electrical equipment for smelters; L.1902 electrical equipment for mine pumps; L.1358 electrical equipment for mine fans; and L.3657 covers motors for crushing and concentrating mills. All leaflets are amply illustrated.

Compressors. Bulletin 77-I of the Sullivan Machinery Co., Chicago, describes the Sullivan line of portable mine-car air compressors, motor-driven, Class WK 26. It contains 16 pages, illustrated. Bulletin 77-J covers portable air compressors WK 311, WK 32 and WK 34. These three types are respectively driven by gas engine, by belt from electric motor, and by belt from a tractor. Another leaflet gives the specifications for the portable compressor WK 311 referred to.

Concrete Breaker. Bulletin 81 D of the Sullivan Machinery Co., Chicago, describes the Sullivan compressed-air concrete-breaker hammer drill, Class DB-221, weighing 65 lb., for use in removing concrete in construction work.

THE MARKET REPORT

Daily Prices of Metals

Mar.	Copper, N. Y. net refinery*	Tin		Lead		Zinc
	Electrolytic	99 Per Cent	Straits	N. Y.	St. L.	St. L.
6	13.50@13.75	56.50	57.00	9.025	9.05	6.625@6.65
7	13.75	56.25	56.75	9.025	9.05	6.575@6.60
8	13.75	56.25	56.75	9.025	9.05	6.575@6.60
10	13.75	57.125	57.625	9.025	9.05	6.55
11	13.75	57.875	58.375	9.00	9.05	6.50@6.525
12	13.75	58.25	58.75	9.00	9.05	6.50@6.525
Av.	13.729	57.042	57.542	9.017	9.05	6.565

*These prices correspond to the following quotations for copper delivered: March 6th, 13.75@14c.; 7th to 12th inclusive, 14c.

The above quotations are our appraisal of the average of the major markets based generally on sales as made and reported by producers and agencies, and represent to the best of our judgment the prevailing values of the metals for deliveries constituting the major markets, reduced to the basis of New York cash, except where St. Louis is the normal basing point, or as otherwise noted. All prices are in cents per pound. Copper is commonly sold "delivered," which means that the seller pays the freight from the refinery to the buyer's destination.

Quotations for copper are for ordinary forms of wire bars, ingot bars and cakes. For ingots an extra of 0.05c. per lb. is charged and there are other extras for other shapes. Cathodes are sold at a discount of 0.125c. per lb.

Quotations for zinc are for ordinary Prime Western brands. Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

The quotations are arrived at by a committee consisting of the market editors of *Engineering and Mining Journal-Press* and a special representative of the Bureau of Mines and the Bureau of Foreign and Domestic Commerce.

London

Mar.	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic						
	Spot	3M		Spot	3M	Spot	3M	Spot	3M
6	66⅞	67¾	72	293	292	39⅜	38	36⅛	35⅞
7	68	68⅞	73	292¼	291¾	39⅝	38⅜	36	35⅞
10	68¼	69⅛	73¾	292¾	292	39¼	37⅞	35¾	36
11	68⅝	69½	73¾	296½	295¾	39¼	38	35⅞	36
12	68⅛	69	73¾	297½	296¾	39⅜	38½	36⅝	36½

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver, Gold, and Sterling Exchange

Mar.	Sterling Exchange "Checks"	Silver		Gold London	Mar.	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
6	4.29⅜	64¼	33 9/16	95s 11d	10	4.26¾	64¼	33 13/16	96s 8d
7	4.27⅞	64	33½	96s 1d	11	4.26½	64	33¾	96s 9d
8	4.26½	64	33⅝	.....	12	4.29¾	64¼	33⅝	95s 11d

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London silver quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command one-quarter of a cent premium.

Metal Markets

New York, March 12, 1924

The week has been a quiet one in the non-ferrous metal markets, with prices moving within a narrow range. Copper and tin are somewhat higher, but lead and zinc have registered slight declines from the prices quoted a week ago. Consumption in this country shows every prospect of continuing at the same high rate maintained last year.

Copper

When copper reached 14c. delivered last week there was a slight reaction owing to substantial tonnages coming on the market for immediate sale, but since last Thursday this pressure has been removed and producers have stood for 14c. delivered, almost without exception. There is no doubt that this strength was inspired by the advance in London, which made it more profitable to sell in that market than on this side. Certainly consumers here have not been responsible for any advance in price, for buying has been on an extremely limited scale. Consumption seems as good as ever, but for the time being supplies of copper have been well provided for. In our news pages will be found recent statistics which show an increasing foreign demand. This is particularly encouraging, for it is to Europe chiefly that we must look for a market for the increased amount of copper now being produced.

Copper for near-by delivery is somewhat easier to obtain at 14c. than that for shipment several months hence, but some producers are willing to book orders for June at that price. There seems to be little tendency at present to offer concessions to consumers who have their plants near refineries, 14c. being considered none too much for any one to pay. In fact one producer today was able to get 14⅛c.

Lead

The official contract price of the American Smelting & Refining Co. continues at 9c., New York.

The easier tendency in the lead market noted in our market report for last week has continued, with successive decreases in the premiums asked for spot and prompt deliveries until yesterday, when a prominent consumer was able to get a substantial tonnage of spot lead for 9c., New York, the same price that is asked for April and May shipment. Without doubt, the recession first noted last week has brought out hidden supplies, and it is also probable that miners will endeavor to clean out as much ore as possible, so that smelter production may take a sudden impetus. The fundamental condition continues strong, however, and there is nothing to indicate a further weakening of the market. Consumption continues on almost as great a scale as ever, and the increase in the amount of available lead is to be attributed to increased production rather than decreased consumption. It is of interest to note that the London quotation has not declined, and there is no doubt that more of the Mexican production will be required overseas than has recently been going in that direction. This will operate to prevent any oversupply in the New York market.

In the Middle West, conditions are also easier. During most of the week, April and May lead has been available at 9c. St. Louis and 9.05c. Chicago. In the last two or three days spot and prompt metal has been sold for 9.30@9.35c. by producers, though the requirements are not large. Chemical lead is scarcer than desilverized. Some sellers are still quoting 9½@9¾c. for prompt lead in the Middle West, but there seems no necessity of paying such premium prices.

Zinc

The zinc market has sagged because of the absence of buying from galvanizers. Yesterday and today Prime Western metal was sold as low as 6.50c. per lb. East St. Louis, whereas earlier in the week it brought 6.65c. Export sales were made in small volume, but speculative interests seem to be active in the market for foreign shipment, without giving the market much confidence, however. Germany seems to

be a particularly active participant in purchases. The statistics of the American Zinc Institute for February show a decrease in stocks amounting to about 3,500 tons. Production was 43,933 tons, stock on hand, Feb. 1, 40,697, shipments 47,438, stock on hand Feb. 29, 37,192 tons. The failure of the market to respond to this favorable showing indicates the slight effect which publication of the figures has upon prices. Ore prices in Joplin have declined. High-grade metal remains in good demand at 8¼ to 8¾c. per lb.

Tin

Sales of tin have not been particularly large, though most consumers are operating pretty close to the wind, as is shown by the disinclination to allow any postponement of shipments. Evidently they are waiting for a price reaction before buying much for future requirements. Spot metal is again at a substantial premium, owing to delays to one or two steamers that were due about this time in New York, so that June tin may be bought at concessions of from one to one and a half cents from the prices given for spot. The 99 per cent grade is purely nominal, only an occasional small lot being available.

Arrivals of tin so far in March total 985 long tons.

Silver

The market for the last week has been comparatively steady, with moderate inquiry from India, the quotations both in London and New York being within small range. The general situation is quiet.

Mexican Dollars—March 6, 48⅞; 7th, 48⅞; 8th, 48⅞; 10th, 49; 11th, 48⅞; 12th, 49.

Foreign Exchange

Francs set a new low for all time during the last week, selling down to close to 3½c. Sterling also had a decline. On Tuesday, March 11, cable quotations on francs were 3.875c.; lire, 4.19c.; and Canadian dollars, 2⅞ per cent discount.

Other Metals

Quotations cover large wholesale lots unless otherwise specified.

Aluminum—99 per cent grade, 28c. per lb.; 98 per cent, 27c. London, £115 per long ton. Aluminum Company of America reported to have advanced prices 1c. per lb. in last week.

Antimony—Per lb.
Chinese and Japanese brands, 11¼@11½c.
W. C. C. brand, 13@13½c.
Cookson's "C" grade, 14½c.
Chinese needle, lump, nominal, 8½@9c.
Standard powdered needle, 200 mesh, 9@10c.
White oxide, Chinese, 99 per cent Sb_2O_3, 9½@10c.

Bismuth—$2.35@$2.45 per lb. London, 10s.

Cadmium—70@75c. per lb. London, 2s. 6d.

Cobalt—$2.50@$3 per lb. for spot.

Iridium—$175@$300 per oz.

Nickel—26c. per lb. for 99 per cent virgin metal. London, £130 long ton.

Osmiridium—Crude, $58.50 per oz.

Palladium—$83 per oz. Crude, $60 per oz.

Platinum—Refined, $123 per oz.
Crude platinum, $114@$115 per oz.
Market slightly easier but offerings light.

Quicksilver—$59@$61 per 75-lb. flask. San Francisco wires $60.00. London, £9 15s.

The prices of **Magnesium, Molybdenum, Monel Metal, Osmium, Radium, Rhodium, Selenium, Tellurium, Thallium,** and **Tungsten** are unchanged from prices given March 8.

Metallic Ores

Chrome—$19.50@$24, depending upon grade and source. Nominal.

Manganese—44@46c. per long ton unit, seaport, plus duty.

Molybdenum—80c. per lb. of MoS_2 for 85 per cent concentrates. Nominal.

Tungsten Ore—Per unit, N. Y.
High-grade wolframite, $9@$9.25.
High-grade scheelite, $10.
Ordinary grades, $8.75@$9.

Iron Ore, Magnetite, Tantalum, Vanadium, and **Zircon Ore** are unchanged from March 8 quotations.

Zinc and Lead Ore Markets

Joplin, Mo., March 8—Zinc blende, per ton, high, $46.75; basis 60 per cent zinc, premium, $44@$43; Prime Western, $42@41; fiines and slimes, $40@$37; averaged settling price, all blende, $42.19; calamine, basis 40 per cent zinc, $22.

Lead, high, $128.30; basis 80 per cent lead, $125; average settling price, all lead ore, $123.85 per ton.

Shipments for the week: Blende, 17,900; calamine 92; lead, 2,276 tons. Value, all ores the week, $1,039,180.

Reports of a receding price on lead ore could not be verified, buyers reporting the same basis price as last week. A total of 15,920 tons of zinc is reported purchased today, or approximately the output. It is reported there remains in the bins only 30,000 tons of unsold ore.

Platteville, Wis., March 8—Blende, basis 60 per cent zinc, $47 per ton. Lead, basis 80 per cent lead, $125 per ton. Shipments for the week: Blende, 397 tons; lead, none. Shipments for the year: Blende, 5,112; lead, 200 tons. Shipments for the week to separating plants, 481 tons blende.

Non-Metallic Minerals

Asbestos:
Crude No. 1—$300@$400.
Crude No. 2—$175@$225.
Spinning fibers—$90@$150.
Magnesia and compressed sheet fibers—$60@$90.
Shingle stock—$50@$70.
Paper stock—$32.50@$40.
Cement stock—$20@$25.
Floats—$7@$9.
All per short ton, f.o.b. mines, Quebec, tax and bags included.

Bauxite, Barytes, Beryl, Borax, Chalk, China Clay, Diatomaceous Earth, Emery, Feldspar, Fluorspar, Fuller's Earth, Garnet, Graphite, Gypsum, Ilmenite, Limestone, Magnesite, Manjak, Mica, Monazite, Ocher, Phosphate, Pumice, Pyrites, Rutile, Silica, Sulphur, Talc, Tripoli and **Zircon** are unchanged from March 8 prices.

Mineral Products

Arsenious Oxide (white arsenic)—12@12½c. per lb., the higher prices being obtained for small tonnages of spot. Demand not yet active.

Copper Sulphate—4.90@5c. per lb. Imported material slightly less.

Zinc Oxide—Per lb. in bags:
Lead free, 7⅞c.
5 per cent lead sulphate, 7½c.
10 to 35 per cent lead sulphate, 7c.
French, red seal, 9¾c.
French, green seal, 10¾c.
French, white seal, 12c.

Potassium Sulphate, Sodium Sulphate and **Sodium Nitrate** are unchanged from the March 8 prices.

Ferro-Alloys

Ferrochrome, Ferromanganese, Ferromolybdenum, Ferrosilicon, Ferrotitanium, Ferrotungsten, Ferro-uranium and **Ferrovanadium** are unchanged from the prices given in the March 8 issue.

Metal Products

Copper—Sheets, 21¾c. base; wire, 16⅜c.

Lead Sheets — Cut, 12.75c.; full, 12.50c. per lb.

Nickel Silver—18 per cent Grade A sheets, 27½c.

Yellow Metal—Dimension sheets, 19½c.; rods, 16½c.

Zinc Sheets—Base price, $9.75 per 100 lb., f.o.b. plant.

Refractories

Bauxite Brick, Chrome Brick, Firebrick, Magnesite Brick, Magnesite Cement, Silica Brick and **Zirkite** are unchanged from the March 8 prices.

The Iron Trade

Pittsburgh, March 11, 1924

With 114,472 tons increase in unfilled obligations during February, the Steel Corporation made a better showing for sales than had been expected in many quarters. The monthly report of steel ingot production shows that the rate in February averaged 47,000,000 tons per annum.

Steel buying is fairly active. Plates and shapes are irregular in price, but are said to be steadier than in January. The scrap markets have been dull for several weeks, and prices have been softening slightly, but on account of the open winter present offerings are lighter than usual for the season.

Pig Iron—With still another week of extreme dullness the pig iron price outlook has become less favorable, but prices are not quotably lower: Bessemer, $23.50; basic, $22; foundry, $23, f.o.b. Valley furnaces.

Connellsville Coke.—Offerings of spot furnace coke continue light, whereby with only a very moderate demand the $4.25 price is sustained. The $4.50 asking price on second quarter has disappeared as a serious quotation. Some uncovered consumers refuse to negotiate. Spot foundry coke remains at $5@$5.50.

Freight Rates on Metals, Ores, and Concentrates

Carload Lots

Copper Bullion and Refined Copper

From	To	Rate per Ton of 2,000 Lb. All Rail	Via Gulf
El Paso, Tex.	Baltimore, Md.	$11.40	$10.00
Garfield, Utah	Perth Amboy	12.50	.....
Garfield, Utah	San Francisco	5.85	.....
Hayden, Ariz.	Perth Amboy	14.50	12.50
Miami, Ariz.	Perth Amboy	14.50	12.50
Anaconda, Mont.	Perth Amboy	12.50	.....
Butte, Mont.	Perth Amboy	12.50	.....
Humboldt, Ariz.	Chrome, N. J.	14.50	12.50
Douglas, Ariz.	Perth Amboy	14.50	12.50
Globe, Ariz.	Perth Amboy	14.50	12.50
Clifton, Ariz.	Perth Amboy	14.50	12.50
Clarkdale, Ariz.	Chrome, N. J.	14.50	12.50
Copperhill, Tenn.	Laurel Hill, N. Y.	$10.80	.....
Tooele, Utah	Chrome, N. J.	12.50	.....
McGill, Nev.	Baltimore, Md.	15.90	.....
Houghton, Mich.	New York	(a) 11.40	.....
Hancock, Mich.	New York	(a) 11.40	.....
Hubbell, Mich.	New York	(a) 11.40	.....
Dollar Bay, Mi h.	New York	(a) 11.40	.....
Tacoma, Wash.	New York Conference rate via Canal		$6.00
Anaconda, Mont.	Tacoma, Wash.	7.09	.....
Ajo, Ariz.	New York	14.50	$12.50

(a) Applies Dec. 1 to April 1.

Marine Freight Rates

New York to
- Hamburg: $4.00 per gross ton copper and lead
- Liverpool: $4.00 per gross ton copper and lead
- Antwerp: $3.50 per gross ton copper and lead
- Havre: $3.75 per gross ton lead; $4.25 per gross ton copper

Gulf ports to
- Hamburg: $4.00 per gross ton copper and lead
- Liverpool: $4.00 per gross ton copper and lead
- Antwerp: $3.50 per gross ton copper and lead
- Havre: $4.25 per gross ton copper

Pacific coast ports to
- Hongkong: $6.00 per short ton
- Kobe: $6.00 per short ton

Tampico to
- Liverpool Bremen, Hamburg, Rotterdam
- Havre: $4.50 per metric ton
- Dunkirk: $6 per metric ton

Lead Bullion; (Pig Lead Where Shown)

From	Rates per Ton of 2,000 Lb. To New York	To St. Louis
East St. Louis, Ill.	$7.00	.....
Pueblo, Colo.	14.15	$9.65
Leadville, Colo.	(c)* 12.50	(c)* 9.50
East Helena, Mont	(c)* 12.50	(c)* 9.50
El Paso, Tex.	10.00 Via Gulf	
	(c)* 12.00 All Rail	(b) 7.76½
Omaha, Neb.	9.60	3.65
Murray, Utah	(c)* 12.50	(c)* 9.50
Midvale, Utah	(c)* 12.50	(c)* 9.50
Tooele, Utah	(c)* 12.50	(c)* 9.50
East Chicago, Ill.	6.40	(a) 2.00
Kellogg, Idaho	(c)* 12.50	(c)* 9.50
Carnegie, Pa.	3.80	(a) 5.00
Selby, Calif.	(d) 6.00	.....
Herculaneum, Mo.	(a) 8.80	(a) 1.80
Federal, Ill.	7.00	(a) 1.80
Collinsville, Ill.	7.00	(a) .75½
Granby, Mo.	(a) 10.50	(a) 3.50
Joplin, Mo.	(a) 10.50	(a) 3.50

(a) Pig lead only.
(b) Pig lead only when originating in Mexico.
(c) Note—Reduced rates effective:
Montana to seaboard, March 15
Utah to seaboard, Feb. 29
Idaho to seaboard, March 15
Leadville to seaboard, Feb. 29
(d) Conference rate, via canal.

Slab Zinc

From	Rates per Net Ton to E. St. Louis	New York
Donora, Pa.	(a) $4.60	$3.80
Langeloth, Pa.	(a) 4.60	3.80
Palmerton, Pa.	7.10	3.00
Hillsboro, Ill.	1.40	7.00
Danville, Ill.	2.00	6.40
La Salle, Ill.	2.00	6.70
Springfield, Ill.	3.00	7.00
Cleveland, Ohio	5.80	5.00
Moundsville, W. Va.	4.40	3.80
Van Buren, Ark.	3.80	10.80
Fort Smith, Ark.	3.80	10.80
Bartlesville, Okla.	3.50	10.50
Blackwell, Okla.	3.80	10.80
Henryetta, Okla.	3.80	10.80
Sand Springs, Okla.	3.80	10.80
Cherryvale, Kan.	3.50	10.50
Black Eagle, Mont.	9.40	12.50
Park City, Utah	9.00	12.50

(a) To St. Louis Mo.

Zinc Ores and Concentrates

To	From	Rate per Net Ton
Bartlesville, Okla.	Altoona, Kan.	$2.10
	Pittsburg, Kan.	1.09
	Galena, Kan.	1.30
	Joplin, Mo.	1.40
	Iola, Kan.	1.09
	Baxter, Kan.	1.40
	Miami, Okla.	1.40
	Quapaw, Okla.	1.40
	Kansas City, Mo.	1.60
Sand Springs, Okla.	Miami, Okla.	2.20
	Quapaw, Okla.	2.20
	Galena, Kan.	1.50
	Joplin, Mo.	1.50
	Iola, Kan.	2.40
Dewar, Okla.	Cave Springs, Mo.	2.00
	Cent City Spur, Mo.	2.00
Kusa, Okla.	Chitwood, Mo.	2.00
Henryetta, Okla.	Galena, Kan.	1.50
	Iola, Kan.	2.40
	La Harpe, Kan.	2.40
La Harpe, Kan.	Mound City, Kan.	.50
	Oswego, Kan.	.50
	Parsons, Kan.	.50
Coffeyville, Kan.	Galena, Kan.	1.10
	Joplin, Mo.	1.22
Bartlesville, Okla. (a)	Baxter, Kan.	1.80
	Miami, Okla.	1.80
	Quapaw, Okla.	1.80

(a) Lead ore and concentrates.

Rates on Ores and Concentrates

From	To	Value of Product Rate $5	$10	$15	$20	$25	$30	$35	$40	$50	$60	$70	$75	$80	$90	$100
Butte, Mont.	Anaconda, Mont.	.17	.17	.17	.17	.17	.17	.17	.17	.17	.17	.17	17	.17	.17	.17
Butte, Mont.	Black Eagle, Mont. (a)	....	....	....	....	....	....	....	1.01	....	....	....	....	....	....	....
Great Falls, Mont.	East Helena, Mont.	....	....	1.57	....	1.76	....	1.98	....	2.43	....	....	....	....	....	2.55
Butte, Mont.	East Helena, Mont.	....	....	1.17	....	1.46	....	1.69	....	2.03	....	....	....	....	....	2.14
Paxton, Calif.	Salt Lake Smelters, Utah	....	....	....	....	....	....	....	....	6.30	7.00	7.70	....	8.35	8.60	8.85
Johannesburg, Calif.	Selby, Calif.	....	....	....	2.90	....	3.50	....	4.10	4.70	5.30	5.90	....	6.50	6.80	7.10
Johannesburg, Calif.	Humboldt, Ariz.	....	....	....	3.40	....	4.10	....	4.80	5.50	6.20	6.90	....	7.60	8.00	8.30
Pioche, Nev.	Humboldt, Ariz.	....	4.50(c)	7.74	....	8.55	....	9.36	....	9.99	....	....	11.25	....	....	12.42
Creede, Colo.	Durango, Colo.	....	....	3.25	3.50	3.75	4.00	....	4.25	4.75	5.25	5.75	6.05	....	....	7.10
Ouray, Colo.	Durango, Colo.	....	....	4.30	4.80	....	5.05	....	....	5.90	....	6.30	....	....	....	7.70
Kokomo, Colo.	Durango, Colo.	....	6.00	....	....	6.50	7.20	....	....	....	....	....	....	....	....	....
Telluride, Colo.	Durango, Colo.	....	....	....	....	....	4.30	....	5.00	5 90	6.30	6.30	....	....	....	7.70
Silverton, Colo.	Durango, Colo.	....	....	1.40	1.40	....	....	2.20	....	....	2.30	2.55	....	2.80	....	2.80
Tyrone, N. M.	Douglas, Ariz.	....	....	1.60	1.90	....	2.20	....	2.50	2 80	....	....	3.40	....	....	3.80
Tyrone, N. M.	El Paso, Tex.	....	....	1.60	1.90	....	2.20	....	2.50	2 80	....	....	3.40	....	....	3.80
Lordsburg, N. M.	Douglas, Ariz.	....	1.00	1.30	1.60	....	1.90	....	2.20	2 50	....	....	2.80	....	....	3.40
Lordsburg, N. M.	El Paso, Tex.	....	1.00	1.30	1.60	....	1.90	....	2.20	2.50	....	....	2.80	....	....	3.40
Tombstone, Ariz.	Douglas, Ariz.	....	....	.60	....	.90	....	....	....	.30	....	....	.60	....	....	1.90
Tombstone, Ariz.	El Paso, Tex.	....	....	1.90	....	2.50	....	....	....	3.80	....	....	.40	....	....	4.40
Silver City, N. M.	Douglas, Ariz.	....	....	2.48	....	3.15	....	....	....	3.83	....	....	....	....	....	5.29
Ray Junction, Ariz.	Hayden, Ariz.	....	.10	....	.40	....	.50	....	.80	.90	....	....	.00	....	....	1.10
Sandon, B. C. / Alamo Concentrator, B. C.	Tadanac, B. C.	1.50	1.60	1.70	1.90	2.00	2.50	....	2.60	2 90	3.40	3.50	....	3.70	3.80	3.90
Rossland, B. C.	Tadanac, B. C.	.90	.90	1.00	1.00	1.10	1.50	....	1.60	1.60	1.60	1.70	....	1.70	1.70	1.70
Rossland, B. C.	Tadanac, B. C(d).	.30	.30	.30	.30	.50	.70	....	.80	.80	....	....	....	....	....	....
Republic, Wash.	Tadanac, B. C.	....	2.02	2.50	2.66	2.86	3.84	....	3.84	3.84	4.69	4.89	....	5.19	5.39	5.59

(a) Minimum tonnage of 200 tons per day. (b) In open cars, minimum 80,000 lb. (c) Siliceous ore tailing.
(d) Applicable on ore, only when shipped in trainload lots of not less than 10 cars and exclusive of switching charges at Rossland.

From	To	Value of Ores and Concentrates Rate $10	$15	$20	$25	$30	$35	$40	$50	$60	$70	$75	$80	$90	$100
Burke, Idaho	Bradley, Idaho	....	....	....	....	....	....	....	....	.68	....	....	....	....	1.02
Burke and Wallace, Idaho	East Helena, Mont.	....	....	....	....	3.00	....	3.25	3.50	3.75	4.00	....	4.25	4.50	4.75
Sagel, Idaho	East Helena, Mont.	....	....	....	3.38	....	3.83	....	4.16	....	....	....	....	....	4.84
Arizona Tunnel, Idaho	Bradley, Idaho	....	....	....	....	....	....	....	....	.35	....	....	....	....	.50
Bayview, Idaho	Bradley, Idaho	....	....	....	....	....	....	....	3.75	....	....	4.37½	....	....	5.12½
Park City, Utah	Salt Lake Smelters	1.00	1.10	1.25	....	1.50	....	1.75	....	2.00	....	....	2.25	....	2.50
Eureka, Utah	Salt Lake Smelters	1.00	....	1.25	....	1.50	....	1.75	2.00	2.25	2.50	....	2.75	3.00	3.25
Tintic, Utah	Salt Lake Smelters	1.00	....	1.25	....	1.50	....	1.75	2.00	2.25	2.50	....	2.75	3.00	3.25
St. Johns, Utah	Salt Lake Smelters	1.00	....	1.25	....	1.50	....	1.75	2.00	2.25	2.50	....	2.75	3.00	3.25
Ophir, Utah	Salt Lake Smelters	1.00	....	1.25	....	1.50	....	1.75	2.00	2.25	2.50	....	2.75	3.00	3.25
Bingham, Utah	Garfield, Utah	....	.40	....	.75	....	....	....	.95	....	....	1.10	....	....	1.25
Cherry Creek, Nev.	Garfield, Utah (c)	....	....	4.60	....	5.10	....	5.60	6.10	6.60	7.10	....	7.60	8.10	8.60
Cherry Creek, Nev.	Garfield, Utah (b)	....	....	3.20	....	3.90	....	4.60	5.30	6.00	6.70	....	7.40	....	....
Goldfield, Nev.	Salt Lake Smelters	....	....	5.10	....	5.80	....	6.50	7.20	7.90	8.60	....	9.30	10.00	10.70
Battle Mountain, Nev. (a)	Salt Lake Smelters	....	4.15	3.20	....	3.80	....	4.40	5.00	5.60	6.20	....	6.80	7.40	8.00
Palisade, Nev. (a)	Salt Lake Smelters	....	....	3.20	....	3.80	....	4.40	5.00	5.60	6.20	....	6.80	7.40	8.00
Mina, Nev. (a)	Salt Lake Smelters	....	....	3.60	....	4.30	....	5.00	5.70	6.40	7.10	....	7.80	8.50	9.20
Lovelock, Nev. (a)	Salt Lake Smelters	....	....	3.20	....	3.90	....	4.60	5.30	6.00	6.70	....	7.40	8.10	8.80
Golconda, Nev. (a)	Salt Lake Smelters	....	....	3.20	....	3.90	....	4.60	5.30	6.00	6.70	....	7.40	8.10	8.80
Hasen, Nev. (a)	Salt Lake Smelters	....	....	3.20	....	3.90	....	4.60	5.30	6.00	6.70	....	7.40	8.10	8.80
Tonopah, Nev.	Salt Lake Smelters	....	4.15	5.10	....	5.80	....	6.50	7.20	7.90	8.60	....	9.30	10.00	10.70
Rogerson, Idaho	Salt Lake Smelters	3.00	....	3.50	....	4.00	....	4.50	5.00	5.50	6.00	....	6.50	7.00	7.50
Georgetown, Colo.	Leadville, Colo.	....	....	3.50	....	3.75	....	4.00	5.00	5.00	5.80	....	5.80	5.80	5.80
Shirley, Colo.	Leadville, Colo.	....	....	2.25	....	2.25	....	2.25	2.25	4.30	4.30	....	4.30	4.30	4.30

(a) Minimum weight, marked capacity of car used, but not less than 80,000 lb. (b) Minimum weight, 80,000 lb. (c) Minimum weight, 40,000 lb.
* Indicates a change of tariff since last report.

The Lead Shortage

By Felix Edgar Wormser
Assistant Editor

BEFORE THE WAR one pound of copper could generally be exchanged for three to four pounds of lead. Today one pound of copper is equivalent in value only to about one and one-half pounds of lead. Such has been the changes in price relation of the two metals! In fact, the rapid and sustained advance in the lead market, which began last summer, has caused many persons to remark that the price of lead might catch up with the price of copper, but with lead over 9c. per lb. in New York and copper at 14c. the spread is still great between the two metals. Lead has already far outstripped zinc in recent price movements, an unusual condition for anyone who is accustomed to look back upon the old price relation. Back of these alterations has been the extraordinary demand for lead and the inability of production to keep step with it.

Yearly Average Price of New York Lead

In Cents per Pound

Year	Price	Year	Price
1895	3.23	1910	4.446
1896	2.98	1911	4.420
1897	3.58	1912	4.471
1898	3.78	1913	4.370
1899	4.47	1914	3.862
1900	4.37	1915	4.673
1901	4.33	1916	6.858
1902	4.069	1917	8.787
1903	4.237	1918	7.413
1904	4.309	1919	5.759
1905	4.707	1920	7.957
1906	5.657	1921	4.545
1907	5.325	1922	5.734
1908	4.200	1923	7.267
1909	4.273	March 12, 1924	9.000

The acuteness of the situation may be appreciated by the fact that Mexican pig lead, which has to hurdle a tariff of 2½c. per lb., has been bought or imported into the United States in large tonnages, whereas normally importations are small. The shortage of lead is not confined to the United States but to Europe as well. Manufacturers abroad seem just as anxious to procure lead as those in this country. Consequently, the London and New York markets have moved parallel with each other, first one and then the other leading.

Some manufacturers have been on the verge of closing their plants, but the shortage has not been so pressing that they have had to do so at the time of writing. Consumers are estimated to have taken during the last sixty days a record amount of lead, well above domestic production.

An advance in the price of lead to a high level is no new thing. Each time this occurs because of a shortage of metal the situation can be relieved by either a decrease in consumption or increased production. Often it has been a decrease in consumption which has eased the situation. High prices have a tendency to discourage consumption, and signs are not wanting that 9c. lead and over may have a similar tendency. Some consumers, among them paint, storage-battery, ammunition and electrical manufacturers, report anxiety over the effect that current prices of lead will have upon the ultimate consumption of their products. At the moment the storage-battery and the cable manufacturers are most active lead consumers. Storage-battery manufacture has been remarkably stimulated by the rapid growth in the manufacture of automobiles, radio sets, automatic telephones, and farm lighting equipment. Should automobile sales fall off—a hazardous thing to predict—storage-battery makers would quickly feel the effect.

It is difficult to point the finger to any lead-consuming industry that shows a marked diminution in its call for lead. Uneasiness among consumers is not preventing them from seeing that they are well supplied with lead.

Another result of high prices will be to encourage substitutions. Fortunately for lead, substitutions for some of its uses are hard to find. Waxed paper may be used in place of lead foil; zinc pigments in place of lead, but what can be used in place of lead in storage batteries or lead covering for cables? High metal prices may also lead to demands for wage increases, which on a turn in the market downward are difficult to reduce without encountering trouble from labor. Hence it is not surprising to note that the principal lead companies are doing their best to prevent a runaway market, for they realize that the reactions caused may prove to be rather harmful to them in the long run.

The lead market has always been noted for the comparative gentleness of its price fluctuations. It is unusual to see the price of lead move violently up or down. The reason for this is the manner in which lead is sold—that is, the desire of producers to confine sales to actual consumers and to remove all speculation in the metal. In the present market prices have moved upward rapidly, but not nearly so fast as they might have, if producers had been inclined to give the market full rein. In one important particular, however, the market differs from its normal state, and that is the prevalence of sales of lead for future delivery. Ordinarily it is in line with the principles of the largest lead companies to sell metal only in amounts sufficient to fill consumer's current needs. They have discouraged the buying of lead far ahead. Today sales of lead have been freely made for delivery three and even four months hence, and at prices that are below those that might be obtained for spot shipment. Producers are doing this in order to help stabilize the market and to ease the anxiety of consumers for future supplies. However, should the lead situation remain unchanged or become more serious, the producers will not have the lead available a few months hence that they customarily possess for monthly sales. This would aggravate the shortage. On the contrary, should the situation become easier, these forward sales will help to smooth the price curve.

The future of the lead market is mainly dependent upon two things—first a continuation of the splendid demand here and, second, its continuation abroad. Europe has been bidding for lead just as intensely as the United States in the present upward movement. The manner in which British consumption has grown in the last three years is illustrated by the following figures in tons:

1921	1922	1923
128,946	154,130	190,216

England draws lead chiefly from Australia, Mexico, Spain, and Burma. That part of Mexican lead which leaves Mexico by way of Tampico can be shipped to England or the United States at almost the same cost, so that it is shuttled between the two destinations, depending upon which market, London or New York, is the best. Incidentally, a large amount of Mexican lead enters the United States through the El Paso gateway, to be smelted on the border. Should consumption abroad decline, some of the lead that is being used in Europe would become available for consumption over here, but so far no indications have been given that consumption is decreasing abroad.

Mexican lead, which has been sold heavily in the United States lately, is sold partly for consumption here and partly for export purposes—bonded lead. Manufacturers with foreign orders to fill demand bonded lead so that they can save the duty. For example, a certain American cigarette which is exported is wrapped in foil made from bonded lead. Exported lead-covered cable and mixed metals may also be made from bonded lead.

There is some reason for believing that lead production both in the United States (about 50,000 tons monthly) and Mexico may increase slightly. Production from Idaho will be augmented by the output of the Hecla Mining Co., which is now being smelted again by Bunker Hill & Sullivan and which is contributing about 1,600 tons monthly to the country's lead. Utah mining districts are also expected to make better showings than they have. Mexican output can also be increased from its present rate of around 15,000 tons monthly. But the increase will be slow. It seems likely that the present shortage will be relieved by a simultaneous decline in consumption and increase in production.

Production of the Leading Lead-Producing Companies

In Short Tons

	1913	1921	1922	1923
American Smelting & Refining Co.	293,870	207,600	252,900	338,300
St. Joseph Lead Co.	66,000	70,900	105,000	95,500
Anaconda Copper Mining Co.	35,000	10,300	9,700	(a) 50,000
Bunker Hill & Sullivan	35,900	37,200	34,700	42,500
Hecla Mining Co.	9,400	19,600	21,200	(a) 12,000
U. S. Smelting, Refining & Mining	29,000	27,360	32,958	29,200
Total United States (U. S. G. S.)	479,000	458,600	540,600	628,000

(a) Estimated.

Company Reports

American Smelting & Refining Co.

A report of operations of American Smelting & Refining Co. for 1923 shows a net income of $8,924,581.56, which compares as follows:

Year	Gross Income	Net Income Available for Dividends(a).
1921	$9,481,471	$1,710,941
1922	15,074,215	5,918,143
1923	20,154,914	8,924,581

(a) After deducting all charges, taxes, bond interest, depreciation, and depletion.

After deducting the 7 per cent dividend (amounting to $3,500,000) upon the company's preferred stock of 500,000 shares, the earnings on the company stock, of 609,980 shares, were $8.89 per share for the year.

Metal Production of the Company

	Year 1923
Gold, oz.	1,871,790
Silver, oz.	94,424,778
Platinum and palladium, oz.	1,615
Lead, tons	338,284
Copper, lb.	834,340,000
Spelter, lb.	59,813,434
Nickel, lb.	452,388
Tin, lb.	5,166,458
Sulphuric acid, lb.	66,386,000
Arsenic, lb.	14,838,789
Copper sulphate, lb.	2,060,000
By-product metals, lb.	13,392,509

Summary of Consolidated Income and Profit-and-Loss Surplus Account

	Year Ended Dec. 31, 1923	Year Ended Dec. 31, 1922
Net earnings, smelting and refining	$16,091,420.46	$12,381,844.12
Net earnings from mining properties	3,465,579.83	2,458,695.40
Total net earnings	$19,557,000.29	$14,840,539.52
Other income—net	597,914.48	233,675.48
Net earnings, before deductions	$20,154,914.77	$15,074,215.00
Deduct		
General and administrative expenses	1,200,642.24	1,079,679.47
Research and examination expenses	178,333.52	56,351.16
Corporate taxes	1,459,350.38	732,210.95
Excess pension payments	.....	43,082.47
Total	$2,838,326.14	$1,911,324.05
Net income from current operations	$17,316,588.63	$13,162,890.95
Less		
Interest on A. S. & R. 5 per cent first mortgage bonds	2,101,499.83	1,785,304.58
Interest on A. S. & R. 6 per cent first mortgage bonds	375,945.12	.....
Interest on Rosita Coal & Coke 6 per cent collateral trust bonds	.....	33,425.67
Depreciation and obsolescence	4,014,595.83	3,774,089.80
Ore depletion	1,899,966.29	1,651,927.96
Total	$8,392,007.07	$7,244,748.01
Net income	$8,924,581.56	$5,918,142.94
Deduct		
Dividends on		
A. S. & R. Co. preferred stock	$3,500,000.00	$3,500,000.00
A. S. & R. Co. common stock	2,287,425.00	.....
A. S. S. Co. preferred "A" stock	30,029.00	376,800.00
A. S. S. Co. preferred "B" stock	2,352.01	38,230.00
Net deduction	$5,819,806.01	$3,915,030.00
Surplus income for year	$3,104,775.55	$2,003,112.94
Balance at beginning of year	15,438,543.07	20,322,077.24
Total	$18,543,318.62	$22,325,190.18
Deduct appropriations and profit-and-loss adjustments	775,532.95	6,886,647.11
Balance at end of year	$17,767,785.67	$15,438,543.07

The outstanding event of the year was the sale of the company's Flat River mines, in Missouri, to the St. Joseph Lead Co. The mines of the two companies were upon the same orebody and interlocked in many places. The mines were turned over to the St. Joseph Lead Co., while the major part of the smelting of the combined tonnage is to be done by the A. S. & R. Co. The terms of the sale and of the smelting contract, which are interdependent, are believed, says the report, to enable each company to make as profits all that it would have made before this sale under divided ownership of the mines and, in addition, its proportionate share of the savings and economies which can be effected by single ownership and operation. Owing to lower mining costs, large quantities of ore will be mined, which under divided ownership would have been left in the ground. Steps have been taken to enlarge the capacity of the company's smelter at Federal, Ill., to accommodate the increased tonnage it will receive under this arrangement.

Consolidated General Balance Sheet, Dec. 31, 1923

Assets

Property account		
Cost of plants less depreciation, and depletion	.....	$114,863,067.76
Investments	.....	4,690,694.79
Total	.....	$119,553,762.55
Miscellaneous assets		
Prepaid taxes and insurance	$1,856,418.49	
Notes receivable	4,094,440.83	
Interplant accounts in transit	22,106.70	
Current assets		
Cash on hand and in transit	$3,053,604.77	
Call loans	1,500,000.00	
Liberty bonds	238,757.30	
Treasury notes and certificates of indebtedness	16,045,390.63	
Total	20,837,752.70	
Accounts receivable	11,791,824.03	
Notes receivable	1,119,292.36	
Materials and supplies	6,234,650.71	
Metal stocks	38,511,861.92	
Cash and securities in funds		
Cash with trustees of sinking fund	180.00	
Employees' pension fund securities	1,7:7,170.26	
Total current and miscellaneous assets	.....	86,195,698.00
Total assets	.....	$205,749,460.55

Liabilities

Bonds outstanding		
A.S.&R. Co. Series "A" 5 per cent first mortgage bonds, 1947	$45,790,900.00	
Less		
Retired through sinking fund	$3,313,200.00	
Held in treasury	978,000.00	
Total	$4,291,200.00	$41,499,700.00
A.S.&R. Co. Series "B" 6 per cent first mortgage bonds, 1947	10,000,000.00	
Less		
Held in treasury	171,000.00	9,829,000.00
Preferred capital stock outstanding		50,000,000.00
Common capital stock outstanding		60,998,000.00
Total		$162,326,700.00

Current and Miscellaneous Liabilities

Current accounts, drafts and wages payable	$9,990,579.15	
Interest on bonds (accrued or unclaimed)	733,703.75	
Dividends		
Unclaimed	80,930.26	
Payable after close of period	1,637,475.00	
Accrued taxes not due	2,913,880.88	
Miscellaneous	2,238,197.45	
Total		$17,594,766.49

Profit-and-Loss Surplus and Reserves

Reserves		
Employees' pension	$2,546,882.19	
Metal stock	5,513,326.20	
Total for reserve accounts	$8,060,208.39	
Profit-and-loss surplus	17,767,785.67	
Total profit-and-loss surplus and reserves		25,827,994.06
Total liabilities		$205,749,460.55

Ohio Copper Company of Utah

Copper; Bingham Canyon, Utah

A report of operations of the Ohio Copper Co. for 1923 states that all operations at the property ceased in March, 1919, and the plants remained closed throughout 1919-1920-1921 and practically through 1922, though experimental operations were successfully conducted in the fall of 1922, and no annual report has been issued since 1918. The deficit reported in 1918, all the charges for the closed-down period (1919 to 1922), and all doubtful assets have been charged off, and all other assets have been adjusted.

"The splendid results produced from leaching have restored the credit of the company and have enabled it to either pay with cash, or fund with its treasury assets, the following items during the year viz:

Coupons due Aug. 1, 1920, to Aug. 1, 1923, from its First Mortgage 7%, which with interest amounted to	$213,005.45
Back taxes	50,470.50
Outstanding notes reduced from $103,500 to $55,000	48,500.00
Total claims paid or funded during year	$312,245.95
In addition the company expended on plant construction repairs, etc., the sum of	152,839.00
Total	$465,084.95

"The company is thereby no longer in default in any respect under its bonds. Its unfunded debt has been reduced to an insignificant amount.

"The largest production for any of the first ten months of the year was made in June, when the net production

was 332,786 lb. About Nov. 1, the larger pumps with a capacity of 1,500 gal. per min. began operating. The production for November and December thereupon almost doubled the production of any of the preceding months. As yet, the plant has not run at full capacity, but gradually it is reaching that stage. At the same time the recovery is well over 95 per cent of the copper value contained in the solution.

"The method of operation, consisting of leaching in place and precipitation, in use at the property, which so far as we know is the first successful operation of its kind, is attracting a wide interest in the industry.

"The caved area from which we are extracting the copper values has a surface of 840,000 sq.ft., and of this we used during the year for the distribution of water a plot not in excess of 2,500 sq.ft. This small area yielded a production of nearly 4,000,000 lb. of copper.

"The ore supply in the present caved area and the uncaved portion of the mine is of sufficient magnitude to warrant the statement that operations at maximum plant capacity can be carried on for many years."

Production for the year amounted to 3,819,417 lb. at a cost of 6.82c. per lb., for which 13.735c. per lb. was received.

Statement of Operating Profits

Operating profit		$264,080.87
Miscellaneous income		236.11
		$264,316.98
Deductions		
Interest on bonds and other indebtedness and discount on bonds	$85,917.85	
Taxes, insurance, transfer and registration expenses —Administration and other miscellaneous charges	51,497.70	137,415.55
Net profit, 1923		$126,901.43
Reserve for depletion, 1923		49,535.69
Balance transferred to surplus		$77,365.74

Assets

Property account	$3,004,860.52	
New leaching plant	165,541.32	$3,170,401.84
Investments—Bingham Central Railway Co. securities		355,830.00
Inventories		34,640.56
Cash		61,737.84
Accounts receivable		17,287.43
Prepaid items		1,006.13
Suspense items		77,452.09
		$3,718,355.89

Liabilities

Capital Stock:			
Authorized		$3,500,000.00	
Reserved for bond conversion	$1,000,000.00		
In treasury	91,265.00	1,091,265.00	$2,408,735.00
Funded Debt:			
First mortgage 7% convertible bonds		$1,000,000.00	
Bonds owned by company		6,600.00	993,400.00
Notes payable (not due)			55,825.00
Accounts payable (current)			26,924.78
Accrued payroll due Jan. 19, 1924			6,321.33
Suspense items, taxes			32,487.22
Special reserve			4,728.00
Reserves, depletion, depreciation			177,735.45
Surplus			
(a) Old surplus (restored)	$797,500.00		
Balance to surplus from 1923 operations	77,365.74	$874,865.74	
Deficit reported 1918	$112,924.50		
Losses—1919-1922, inclusive	582,089.80		
Various adjustments	167,652.33	862,666.63	
Balance			12,199.11
			$3,718,355.89

(a) At the time of the formation of this company, through the reorganization, there existed a donated surplus of $797,500, which was later written off in reduction of property account. In view of the very great improvement in the value of the company's property, owing to the new and successful method of operation, the directors authorized the restoration of this amount to "Surplus Reserve Account."

Iron Cap Copper Co.

Copper; Copper Hill, Ariz.

A report of operations of Iron Cap Copper Co. for the fourth quarter of 1923 states that production was 1,393,198 lb. of copper, 18,620 oz. of silver and 130 oz. of gold.

Income for the quarter	$138,248.98
Expenses for the quarter	139,406.74
Loss	$1,157.76

The dividend of 15c. per share paid May 1, 1923, is deemed to have been a distribution from the depletion reserve. As such it is not considered to be subject to federal income tax.

The Portland Gold Mining Co.

Gold; Victor, Colo.

A report of operations of the Portland Gold Mining Co. for 1923 shows a final loss of $181,135.70 as follows:

Net profit from operation		$35,496.42
Interest paid	$8,221.00	
Less interest received	715.08	
		7,505.92
		$27,990.50
Registration fees, etc.	21.94	
Discount and exchange	411.92	
	433.86	
Less bills collectible—canceled	204.04	
		229.82
Net profit before depreciation and depletion		$28,220.32
Depreciation	$133,309.31	
Depletion	76,946.71	
		209,356.02
Final loss to deficiency account		$181,135.70

Deficiency Account

Balance Jan. 1, 1923	$272,180.39
Loss for the year 1923	118,135.70
Balance Jan. 1, 1924	$453,316.09

Balance sheet as of Jan. 1, 1924, is as follows:

Assets

Cash on hand and in banks		$18,603.15
Bills receivable		8,500.00
Accounts receivable		17,497.30
Stores and supplies at mines and mills		82,688.78
Property:		
Mines	$1,756,315.39	
Mills	500,317.12	
		2,256,632.51
Miscellaneous equipment		287,005.46
		$2,670,927.20

Liabilities

Bills payable		$111,500.00
Accounts payable		11,039.04
Unclaimed wages		668.91
Unclaimed dividends		1,035.34
Capital stock	$3,000,000.00	
Less deficiency	453,316.09	
		2,546,683.91
		$2,670,927.20

Operating Results

Gross value of ore mined and shipped	$675,297.79
Gross value recovered by mill	409,842.02
	$1,085,139.81
Net cost of mining and milling	1,049,643.39
Net profit from operation of mines and mill	$35,496.42

Production amounted to 180,613.37 tons, valued at $1,173,672.40 gross. The average value of the 152,378 tons of ore treated at the Independence mill was $3.32 per ton. Bullion recovered amounted to $409,844.

The report states that it does not show any considerable reduction in the debt of the company because of the heavy expenditures for development work and the necessary improvements made at the mine and mill. The remarkable new orebodies that have been opened up recently on the 27th level of the mine should give the company a net earning, over and above operating costs, sufficient to pay off this indebtedness in the next few months.

St. Mary's Mineral Land Co.

A report of operations of St. Mary's Mineral Land Co. for 1923 shows sales of 1,280 acres of wood and timber for $40,000. Receipts amounted to $831,903.28; expenditures were $84,247.66.

"During 1923 the same lack of interest in our mineral lands prevailed as has been the case for several years back. There were started, however, negotiations for the largest timber sale the company has ever made, comprising 16,757.81 acres. Twelve hundred and eighty acres of this amount were sold and since the first of the year the sale of the balance has been completed. We have been able at the same time to dispose of a portion of a certain right to require the Copper Range Railroad to build spur lines into our timber. The total amount to be received from these sales is somewhat over $600,000 spread over some five years. The exact amount will depend on certain allowances to be made later on account of damages to the timber caused by forest fires in the latter part of 1923," says the report.

"Stockholders have received during the year $3 per share on March 5 and $1 per share on Dec. 11."

MINING STOCKS

Week Ended March 8, 1924

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Alaska-Br. Col.	N. Y. Curb	....	....	*40	....	....
Anaconda	New York	35⅛	33⅛	34⅛	De.15, Ja.21, Q	0.75
Aracadian Consol.	Boston	1⅛	1⅛	1⅛	....	....
Ariz. Com'l.	Boston	9	8⅛	8⅛	Ja.15, Ja.31	0.50
Calaveras	N. Y. Curb	1⅛	1⅛	1⅛	....	....
Calumet & Arizona	Boston	*44⅛	*43¼	*43⅛	Mc.7, Mc.24, Q	0.50
Cal. & Hecla (New)	Boston	16⅛	16	16⅛	De. 1, De. 17	0.50
Canario Copper	N. Y. Curb	2⅜	2⅛	2 1/16	....	....
Cerro de Pasco	New York	47⅛	46⅛	46⅛	Ja. 17, Feb. 1	1.00
Chile Copper	New York	27⅛	27	27⅛	Mh.1 Mh.20, Q	0.62½
Chino	New York	18⅜	17⅛	17⅛	Sept. '20, Q	0.37½
Con. Coppermines	N. Y. Curb	3 3/16	2 13/16	2 13/16	....	....
Copper Range	Boston	25⅛	23	23⅛	May '23, Q	1.00
Crystal Copper	Boston Curb	80	60	72	....	....
Davis-Daly	Boston	4⅛	4⅛	4⅛	Mar. '20, Q	0.25
East Butte	Boston	4⅛	4⅛	4⅛	Dec. '19, A	0.50
First National	Boston Curb	....	....	36	Feb. '19, SA	0.15
Franklin	Boston	*95	*80	*95	....	....
Gadsden Copper	Boston Curb	*50	*40	*40	....	....
Granby Consol.	New York	16	15⅛	15⅛	May '19, Q	1.25
Greene-Cananea	New York	16	15	15	Nov. '20, Q	0.50
Hancock	Boston	....	....	1⅛	....	....
Howe Sound	N. Y. Curb	2⅛	2⅛	2⅛	Ap.1, Ap.15	0.05
Inspiration Consol.	New York	25⅛	24⅛	24⅛	De.20, Ja.7, Q	0.50
Iron Cap	Boston Curb	3	3	3	May 23, K	0.15
Isle Royale	Boston	16	15⅛	16	Se. 1, Se. 15,	0.50
Jerome Verde Dev.	N. Y. Curb	1 7/16	1⅛	1⅛	....	....
Kennecott	New York	37⅛	35⅛	36⅛	Mc.7, Ap. 1, Q	0.75
Keweenaw	Boston	1	*50	1	....	....
Lake Copper	Boston	1⅛	1⅛	1⅛	....	....
Magma Copper	New York	33⅛	32⅛	33	Jan. '19, Q	0.50
Mason Valley	N. Y. Curb	1⅛	1⅛	1⅛	....	....
Mass Consolidated	Boston	*75	*75	*75	Nov. '17, Q	1.00
Miami Copper	New York	22⅛	22	22⅛	Fe. 1, Fe. 13, Q	0.50
Michigan	Boston	....	....	*50	....	....
Mohawk	Boston	*34⅛	*32⅛	*33	Se. 22, Oc. 13,	1.00
Mother Lode Con.	New York	8⅛	8⅛	8⅛	De.14, De.31	0.50
Nevada Consol.	New York	13⅛	13	13⅛	Sept. '20, Q	0.25
New Cornelia	Boston	*18⅛	*17⅛	*17⅛	Au.3, Au.20, Q	0.25
New Dominion	N. Y. Curb	2⅛	2⅛	2⅛	....	....
North Butte	Boston	3	2⅛	2⅛	Oct. '18, Q	0.25
Ohio Copper	N. Y. Curb	*80	*72	80*	....	....
Old Dominion	Boston	17⅛	17⅛	17⅛	Dec. '18, Q	1.00
Osceola	Boston	....	....	31⅛	June '23, Q	1.00
Phelps Dodge	Open Mar.	†135	†130	....	De.20, Ja.2 Q	1.00
Quincy	Boston	21	20	20⅛	Mar. '20, Q	1.00
Ray Consolidated	New York	11⅛	10⅛	10⅛	Dec. '20, Q	0.25
Ray Hercules	N. Y. Curb	*19	*10	*10	....	....
St. Mary's Min. Ld.	Boston	*33	*31	*31	No.9, De.11, K	1.00
Seneca Copper	New York	5⅛	5	5	....	....
Shannon	Boston	*50	*50	*50	Nov. '17, Q	0.25
Shattuck Arizona	New York	6	5⅛	6	Jan. '20, Q	0.25
South Lake	Boston	....	....	⅛	....	....
Superior & Boston	Boston	*85	*85	*85	....	....
Tenn. C. & C. cfs.	New York	8⅛	7⅛	7⅛	De.31, Ja.15, Q	0.25
Tuolumne	Boston	....	....	*42	May '13,	0.10
United Verde Ex.	N. Y. Curb	26⅛	25⅛	26⅛	Ja.1, Fe. 1, Q	1.00
Utah Consol.	Boston	....	....	*1	Sept. '18,	0.25
Utah Copper	New York	67⅜	65⅞	66⅛	Mc.14, Mc.31, Q	1.00
Utah Metal & T.	Boston	*45	*35	*40	Dec. '17,	0.30
Victoria	Boston	....	....	*65	....	....
Walker Mining	N. Y. Curb	3	3	3	....	....
Winona	Boston	*17	*17	*17	....	....
Wolverine	Boston	....	....	5⅜	....	....
NICKEL-COPPER						
Internat. Nickel	New York	13⅛	13	13	Mar. '19,	0.50
Internat. Nickel pfd.	New York	80	79	79	Ja.17, Fe.1, Q	1.50
LEAD						
Carnegie Lead & Zinc	Pittsburgh	6⅞	6	6	....	....
National Lead	New York	142⅛	140⅛	142⅛	Mc.14, Mc.31, Q	2.00
National Lead pfd.	New York	114⅛	114	114⅛	No. 23, De. 15	1.75
St. Joseph Lead	New York	26⅛	26⅛	26⅛	Ju.10, Ju.20, QX	0.50
ZINC						
Am. Z. L. & S.	New York	9⅛	9⅛	9⅛	May '20	1.00
Am. Z. L. & S. pfd.	New York	34	33	34	Nov. '20, Q	1.50
Butte C. & Z.	New York	5⅛	5⅛	5⅛	Mai. '23,	0.50
Butte & Superior	New York	18⅛	17⅛	17⅛	Je.15, Je. 30, Q	0.50
Callahan Zn-Ld.	New York	5	4⅛	4⅛	Dec. '20, Q	0.50
New Jersey Zn.	N. Y. Curb	....	....	151⅛	Ja.31, Fe.9	2.00
United Zinc	N. Y. Curb	....	....	*25	....	....
Yellow Pine	Los Angeles	....	....	*80	Dec. '23	0.03
SILVER						
Alvarado	N. Y. Curb	....	....	1⅛	....	....
Batopilas Mining	New York	....	....	⅛	Dec. '07, I	0.12
Beaver Consol.	Toronto	*29	*25	*29	May '20, K	0.03
Castle-Trethewey	Toronto	†*74⅛	†*67	*74⅛	....	....
Coniagas	Toronto	†2.30	†2.20	2.37	Oc.19, No.1, '23	0.02½
Crown Reserve	Toronto	*67	*63	*63½	Jan. 17,	0.05
Kerr Lake	N. Y. Curb	1⅛	1⅛	1⅛	Oc. 1, Oc. 15, Q	0.12½
La Rose	Toronto	*23	*21	*23	Apr. '22,	0.10
McKinley-Dar.-Sav.	Toronto	*15⅛	*14⅛	*14⅛	Oct. '20, Q	0.03
Mining Corp. Can.	Toronto	†3.44	†3.51	3.50	Sept. '20, Q	0.12½
Nipissing	N. Y. Curb	6⅛	6⅛	6⅛	Ja.1, Ja.21, QX	0.30
Ontario Silver	New York	6⅛	6⅛	6	Jan. '19, Q	0.50
Temiskaming	Toronto	*31	*31	*31	Jan. '20, K	0.40

Stock	Exch.	High	Low	Last		Last Div.
GOLD						
Alaska Gold	New York	⅛	⅛	⅛	....	....
Alaska Juneau	New York	1⅛	1	1⅛	....	....
Carson Hill	Boston	1⅛	1⅛	1⅛	....	....
Cresson Consol. G.	N. Y. Curb	4	3⅞	4	De.31, Ja.10, Q	0.10
Dome Mines	New York	17⅛	17¼	17⅛	Mc.26, Ap.21, Q	0.50
Golden Cycle	Colo. Springs	1.28	1.25	1.25	De. '22, Q	0.02
Hollinger Consol.	Toronto	†11.60	†11.45	11.80	Mc 6, Mc.24, M	0.05
Homestake Mining	New York	51⅛	49⅜	50	Mc.20, Mc.25, M	0.50
Kirkland Lake	Toronto	*21⅛	*18	*21	....	....
Lake Shore	Toronto	†3.75	†3.62	3.88	Fe.2, Fe.24, Q	0.02
McIntyre-Porcupine	New York	16⅛	16⅛	16⅛	De. 1, Ja. 2,	0.25
Portland	Colo. Springs	*52	*50	*52	Oct. '20, Q	0.01
Teck-Hughes	N. Y. Curb	1⅛	1⅛	1⅛	....	....
Tom Reed	Los Angeles	....	....	*49	Dec. '19,	0.02
United Eastern	N. Y. Curb	*92	*88	*90	Ja.8, Ja.28, Q	0.15
Vipond Cons.	Toronto	†1.27	†1.23	1.28	....	....
Wright-Hargreaves	Toronto	3.15	3.15	3.15	Mc.15, Ap.1, Q	0.02½
Yukon Gold	N. Y. Curb	*67	*61	*61	June '18,	0.02
GOLD AND SILVER						
Boston-Mont. Corp.	N. Y. Curb	....	....	*16	....	....
Con. Cortez	N. Y. Curb	*69	*65	*69	....	....
Con. Virginia	San Francisco	*6⅛	*5⅛	*5⅛	....	....
Continental Mines	N. Y. Curb	3	3	3	....	....
Dolores Esperanza	N. Y. Curb	*65	*52	*52	Jy. 1, Jy. 10	Q 0.05
Jib Consol	N. Y. Curb	*25	*23	*25	....	....
Premier Gold	N. Y. Curb	....	....	2	....	....
Tonopah Belmont	N. Y. Curb	*69	*65	*67	Apr. '23, Q	0.05
Tonopah Divide	N. Y. Curb	*37	*37	*37	Se.22, Oc. 10	0.10
Tonopah Extension	N. Y. Curb	1⅞	1 13/16	1 13/16	Mc. 11, Ap. 1	0.05
Tonopah Mining	N. Y. Curb	1⅛	1⅛	1⅛	Se.30, Oc. 1	0.07½
Unity Gold	N. Y. Curb	2⅛	1⅞	2⅛	....	....
West End Consol.	N. Y. Curb	*70	*66	*66	Mar. '23, Q	0.05
SILVER-LEAD						
Ahumada	Boston Curb	....	....	6	Mc., Ap. 2,	0.07½
Bingham Mines	Boston	16⅛	16	16⅛	Sept. 19, Q	0.25
Cardiff M. & M.	Salt Lake	90	85	90	Dec. '20,	0.15
Chief Consol.	Boston Curb	4	3⅞	3⅞	Ja.11, Fe.1, Q	0.10
Columbus Rexall	Salt Lake	*29⅛	*28	*29⅛	Aug. '22	0.03
Consol. M. & S.	Montreal	37⅛	35⅛	35⅛	Oct. '20, Q	0.62½
Daly Mining	Salt Lake	....	....	1.77½	July '20	0.10
Erupcion	Boston Curb	2⅛	2	2	Mc. 15, Ap.2,	0.07½
Federal M. & S.	New York	....	....	11⅛	Jan., '09	1.50
Federal M. & S. pfd.	New York	45⅛	45	45⅛	Fe.26, Mh.15, Q	1.75
Florence Silver	Spokane	*20⅛	*20	*20	Apr. '19, QX	0.01
Hecla Mining	N. Y. Curb	9⅛	9⅛	9⅛	Fe.15, Mh.15	Q 0.25
Indian Mines	N. Y. Curb	....	....	*64	....	....
Iron Blossom Con.	N. Y. Curb	....	....	*31	Oct. 26, '23,	0.02
Marsh Mines	N. Y. Curb	*10	*10	*10	June '21, I	0.02½
Park City	Salt Lake	....	....	4.75	Jan. 24,	0.15
Park Utah	N. Y. Curb	....	....	4⅛	De.8, Ja.2, Q	0.15
Prince Consol.	Salt Lake	....	....	*75	Nov. '17,	0.02
Silversmith	Spokane	*33	*31	*33	Oc. 1, Oc. 10	0.01
Simon Silver-Lead	N. Y. Curb	....	....	*1	....	....
Tamarack-Custer	Spokane	1.75	1.35	1.60	Se.30, Oc. 1, K	0.02
Tintic Standard	Salt Lake	4.40	4.20	4.40	Ja. 5, X	0.25
Utah-Apex	Boston	5⅛	2⅞	3	June '23, QX	0.50
IRON						
Bethlehem Steel	New York	57⅛	56⅛	56⅜	Mh. 1, Ap. 1, Q	1.25
Char. Iron	Detroit	1	1	1	....	....
Char. Iron pfd.	Detroit	1⅛	1⅛	1⅛	....	....
Colorado Fuel & Iron	New York	34⅛	26⅛	32⅛	Fe.11, Fe.25	Q 2.00
Col. Fuel & Iron pfd.	New York	....	....	102	Fe.11, Fe.25, Q	2.00
Gt. North'n Iron Ore	New York	29⅜	28⅛	29⅜	De.10, De.27	2.00
Inland Steel	N. Y. Curb	....	....	46	Mh.15, Apl. 1	Q 0.62½
Mesabi Iron	N. Y. Curb	....	....	6⅛	....	....
Replogle Steel	New York	11⅛	10⅛	11⅛	....	....
Republic I. & S.	New York	57⅛	55⅛	56⅛	May '21	1.50
Republic I. & S. pfd.	New York	95	94⅛	94⅛	Mh.20, Ap.1	QX 2.75
Sloss-Sheffield S.&I.	New York	64⅛	63	64	Mc.10, Mc.20	1.50
Sloss-Shef. S.&I.pfd.	New York	....	....	84	De.20, Ja.2, Q	1.75
U. S. Steel	New York	104⅛	102⅛	103	Mc. 29, QX	1.75
U. S. Steel pfd.	New York	119⅛	119	119⅛	Mc. 29, Q	1.75
Virginia I. C. & C.	New York	....	....	49	De.15, Ja. 2	1.50
Virginia I.C.&C.pfd.	New York	....	....	80	De.15, Ja.22	2.50
VANADIUM						
Vanadium Corp.	New York	31⅛	30⅛	30⅛	Jan. '21, Q	1.00
ASBESTOS						
Asbestos Corp.	Montreal	35	32	35	Se.29, Oc.15	Q 1.00
Asbestos Corp. pfd.	Montreal	60	58	58	Se.29, Oc.15, Q	1.50
SULPHUR						
Freeport Texas	New York	10⅜	9⅞	10⅛	Nov. '19, Q	1.00
Texas Gulf	New York	61⅛	61	61⅛	Mh.3, Mh.15	QX 1.75
PLATINUM						
So. Am. Gold & P.	N. Y. Curb	4	3⅞	3⅞	....	....
MINING, SMELTING AND REFINING						
Amer. Metal	New York	43⅛	42⅛	43⅛	Fe.18, Mh.1, Q	0.75
Amer. Metal pfd.	New York	....	....	112	Fe.20, Mh.1, Q	1.75
Amer. Sm. & Ref.	New York	61⅛	60⅛	60⅜	Ja. 11, Fe. 1, Q	1.25
Amer.Sm.&Ref.pfd.	New York	99	98⅛	98⅛	Fe.20, Mh.1,	1.75
U. S. Sm. R. & M.	New York	22⅛	21⅞	22	Jan. '21, Q	0.50
U.S. Sm. R.&M.pfd.	New York	40⅛	40	40⅛	Ja.7, Ja.15	Q 0.87½

* Cents per share. † Bid or asked. Q, Quarterly. SA, Semi-annually. M Monthly. K, Irregular. I, Initial, X, Includes extra.

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